Nokia Customer Care
NPL-4/5 Series Transceivers

Troubleshooting Instructions

Issue 1 05/04
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RF Troubleshooting

Introduction to RF troubleshooting

Measurements should be done using Spectrum analyzer with high-frequency high-impedance passive probe (LO-/reference frequencies and RF power levels) and Oscilloscope with a 10:1 probe (DC-voltages and low frequency signals)

The RF-section is built around one RF-ASIC (Helgo N500). For easier troubleshooting, this RF troubleshooting document is divided in to sections.

Before changing Helgo, please check following things: Supply voltages are OK and serial communication is coming from baseband to Helgo.

Please note that the grounding of the PA module is directly below PA-module so it is difficult to check or change. **Most RF semiconductors are static discharge sensitive!** So ESD protection must be taken care of during repair (ground straps and ESD soldering irons). Helgo and PA are moisture sensitive so parts must be pre-baked prior to soldering.

Apart from key components described in this document here are a lot of discrete components (resistors, inductors and capacitors) which troubleshooting is done by checking if soldering of the component is done properly (for factory repairs checking if it is missing from PWB). Capacitor can be checked for shortening and resistors for value by means of an ohmmeter, but be aware in-circuit measurements should be evaluated carefully.

Please be aware that all measured voltages or RF levels in this document are rough figures. Especially RF levels varies due to different measuring equipment or different grounding of the used probe. When using RF probe usually a good way is to use metallic tweezers to connect probe ground to PWB ground as close to measurement point as possible.

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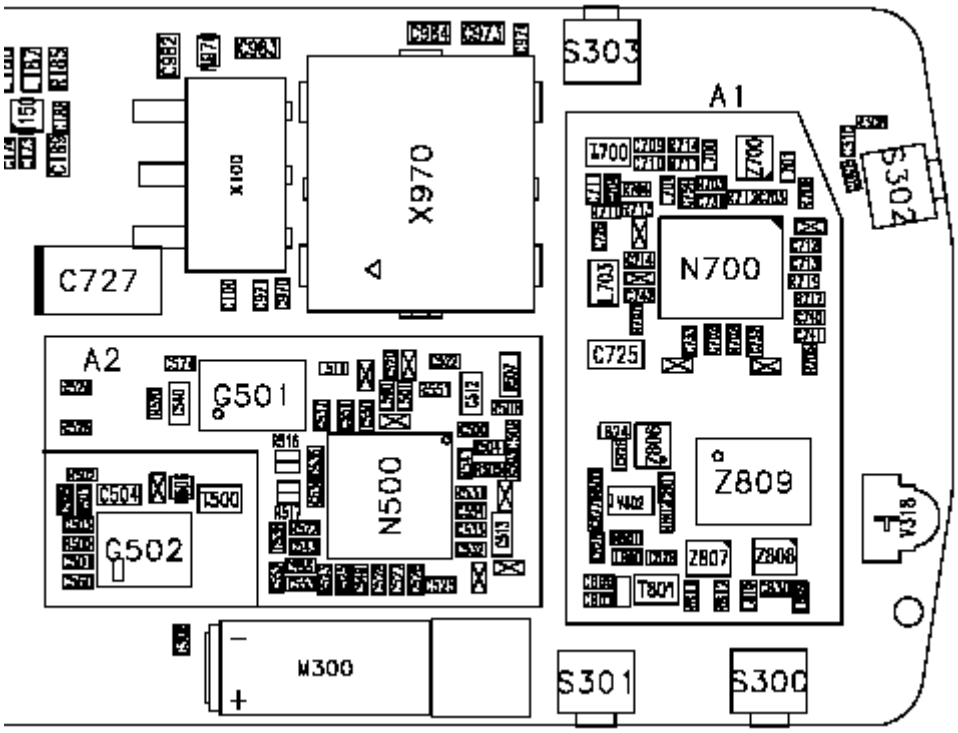
RF Key component placement

Figure 1: Component placement 1



Position	Component Name	Supplier and Description	Code
All variants:			
Z809	Antenna Switch Module	Murata	4550305
N700	TX-PA	RFMD	435B136
Z807	SAW 1800 RX	Murata	4511457
Z806	SAW 1900 RX	Murata	4511459
N500	RF ASIC (Helgo8.5)	ST Microelectronics	4371005
G501	VCTCXO	NDK	4510417
G502	VCO	Matsushita	435B104
850 only:			
Z808	SAW 850 RX	Murata	4511449
Z700	SAW 850 TX	Murata	4511445

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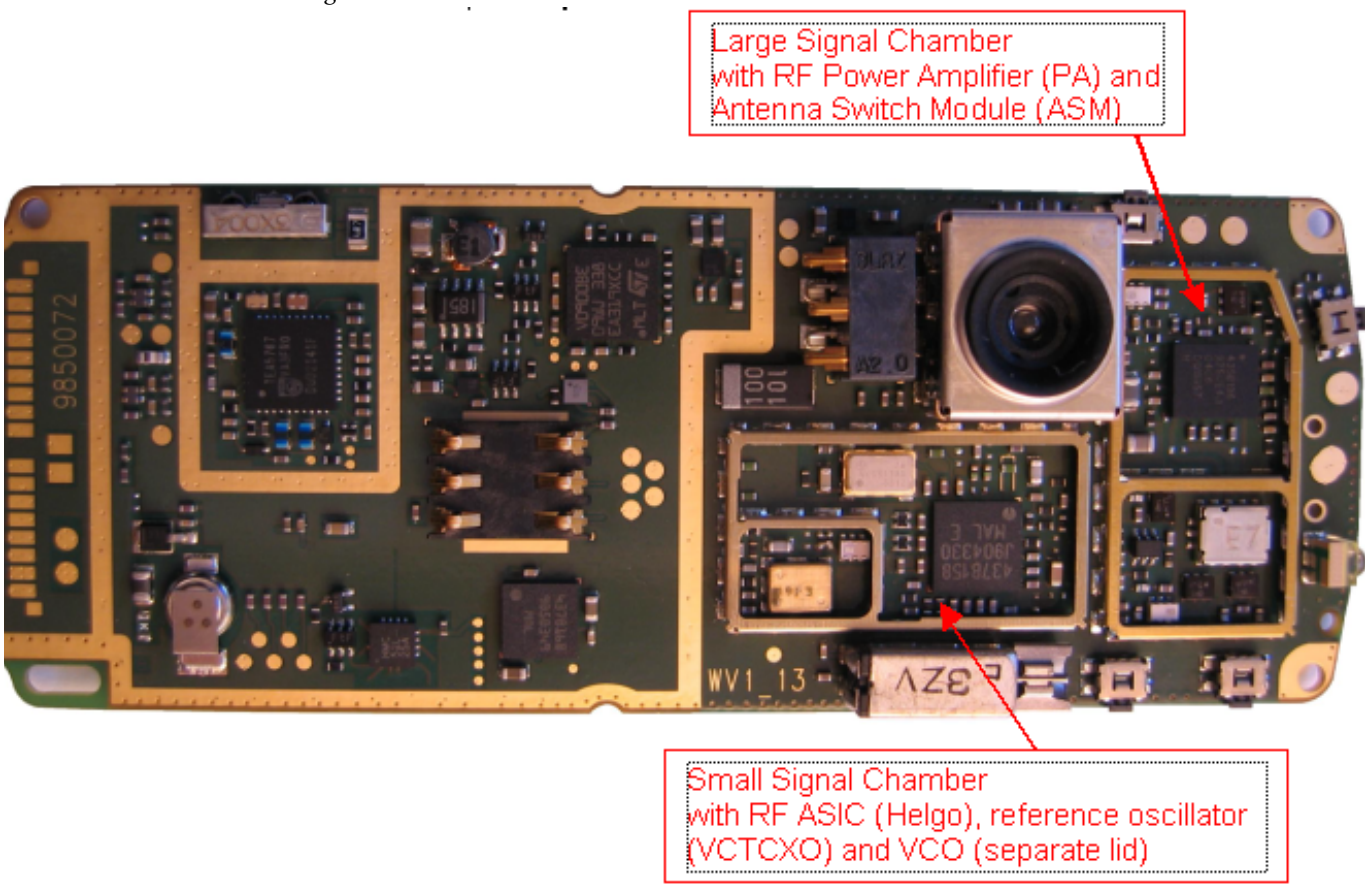
RF Test Points

The RF power supplies are generated in the UEM and can be measured either in the Small Signal Chamber or in the Baseband Chamber. On the drawings below small points show the locations of the test points.

Figure 2: Picture of the Assembled PWB with Chambers


Large Signal Chamber
with RF Power Amplifier (PA) and
Antenna Switch Module (ASM)
Small Signal Chamber
with RF ASIC (Helgo), reference oscillator
(VCTCXO) and VCO (separate lid)

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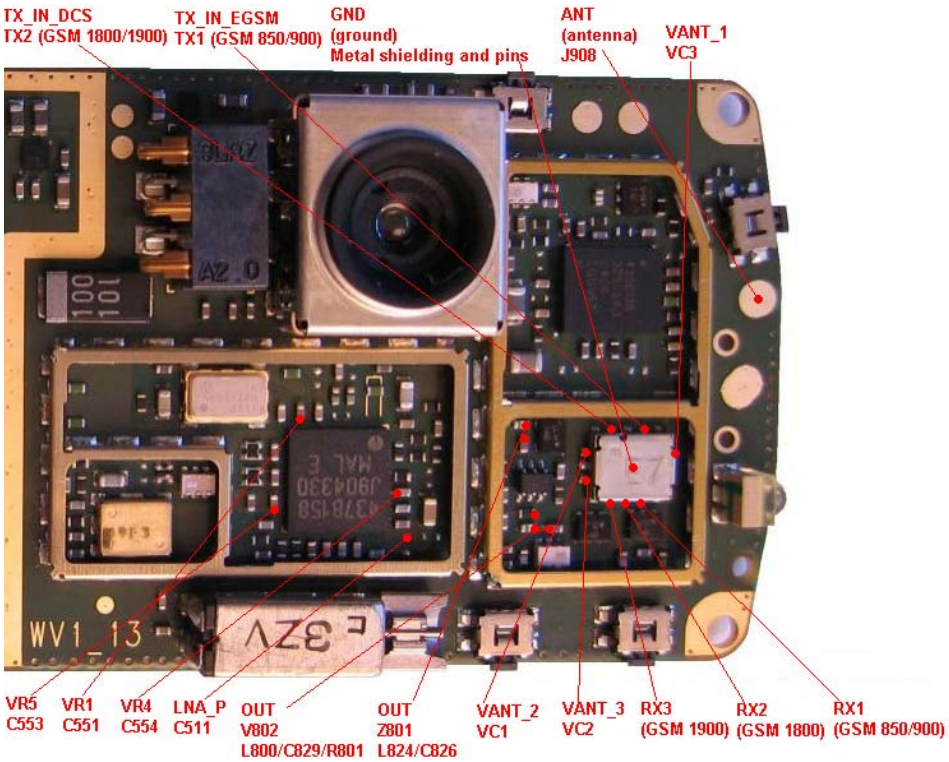
Receiver

Figure 3: Receiver Test Points



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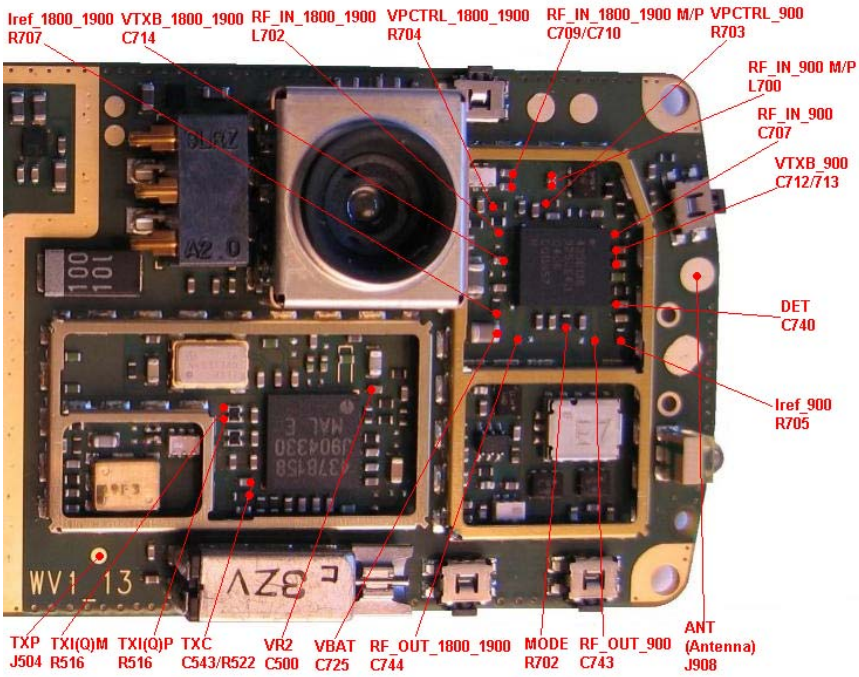
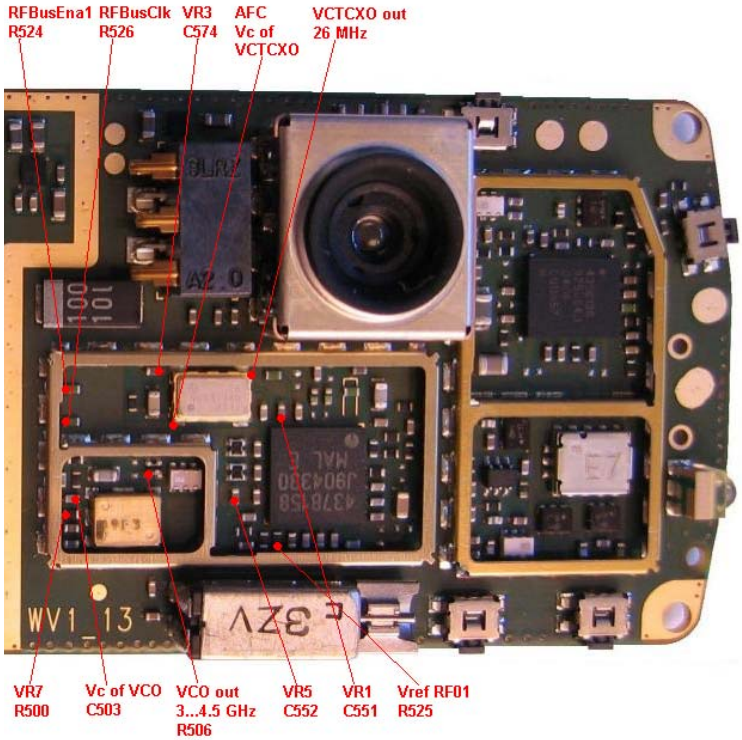
Transmitter

Figure 4: Transmitter Test Points



Synthesizer

Figure 5: Synthesizer Test Points



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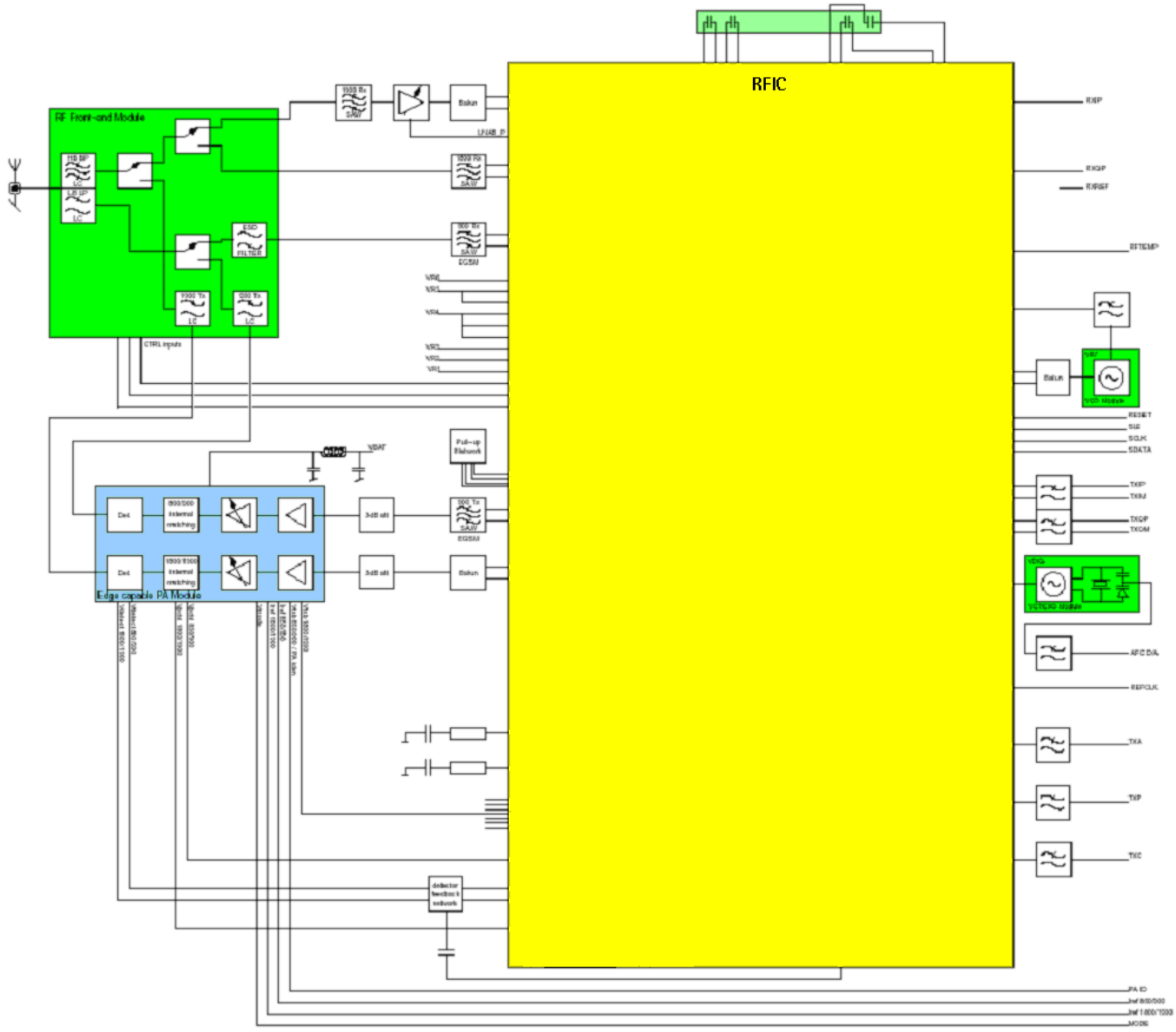
RF in General

Figure 6: RF Block -Diagram



RF block diagram consisting of:

- RF front-end module
- Power amplifier module
- RF ASIC
- VCTCXO module
- VCO module

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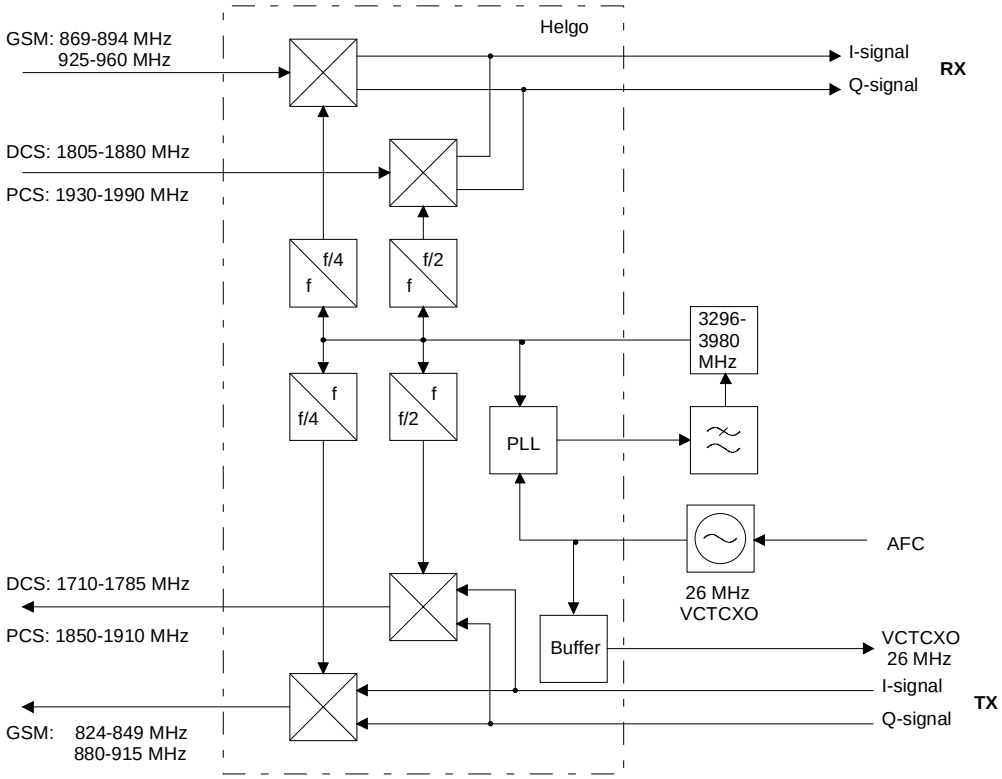
The RF front-end is a triple-band direct conversion transceiver. Using direct conversion, no intermediate frequencies are used for up- or down-conversion.

Figure 7: RF Power Supply Configuration



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RF Power Supply Configuration

General Specifications of Transceiver

Parameter	Unit
Cellular System	GSM850/900, GSM1800, GSM1900
Modulation schemes	GMSK, 8-PSK
RX Frequency Band	GSM850:824 ... 849 MHz GSM900:925 ... 960 MHz GSM1800:1805 ... 1880 MHz GSM1900:1930 ... 1990 MHz
TX Frequency Band	GSM850:869 ... 894 MHz GSM900:880 ... 915 MHz GSM1800:1710 ... 1785 MHz GSM1900:1850 ... 1910 MHz
Output Power GMSK	GSM850:+5 ... +33 dBm (3.2 mW ... 2 W) GSM900:+5 ... +33 dBm (3.2 mW ... 2 W) GSM1800:+0 ... +30 dBm (1.0 mW ... 1 W) GSM1900:+0 ... +30 dBm (1.0 mW ... 1 W)
Output Power 8-PSK	GSM850:+5 ... 27 dBm (3.2 mW ... 0.5 W) GSM900:+5 ... 27 dBm (3.2 mW ... 0.5 W) GSM1800:+0 ... 26 dBm (1.0 mW ... 0.4 W) GSM1900:+0 ... 26 dBm (1.0 mW ... 0.4 W)
Duplex Spacing	GSM850:45 MHz GSM 900:45 MHz GSM 1800:95 MHz GSM 1900:80 MHz
Number of RF Channels	GSM 850:124 GSM 900:174 GSM 1800:374 GSM1900:299
Channel Spacing	200 kHz (each band)
Number of TX Power Levels GMSK	EGSM:15 GSM 900:15 GSM 1800:16 GSM 1900:16
Number of TX Power Levels 8-PSK	GSM 850:12 GSM 900:12 GSM 1800:14 GSM 1900:14
Sensitivity, static channel (+25°C)	EGSM:-102 dBm GSM 900:-102 dBm GSM 1800:-102 dBm GSM 1900:-102 dBm

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Frequency Error, static channel	< 0.1 ppm
RMS Phase Error	< 5.0 °
Peak Phase Error	< 20.0 °

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Receiver Verification and Troubleshooting

General instructions for RX troubleshooting

Connect the phone to a PC, which has Phoenix Service Software and a dongle installed, using either

- Repair jig and DAU-9S (RS232) cable or
- DAU-9T cable (RS232) or
- DKU-5 cable (USB)

Connect the phone to a power supply (DC voltage: 4.0V, max. current: 3A) and an RF signal generator. Switch the phone on.

Start Phoenix Service Software and open FBUS connection.

- Select → Scan Product (Ctrl-R)

Wait until phone information (NPL-4 or NPL-5) is shown in the lower right corner of the screen.

Follow the instructions below.

Measuring RX I/Q Signals using RSSI Reading

- Start Phoenix Service Software and open FBUS connection.

- Select → Scan Product (Ctrl-R)

Wait until phone information is shown in the lower right corner of the screen.

- Set operating mode to local mode

- Select → Testing → RF Controls

- Select → Band → GSM 850 or GSM 900 or GSM1800 or GSM1900

Active unit → RX

Operation mode → Burst

RX/TX Channel → 190 or 37 or 700 or 661

- Select → Testing → RSSI reading

In the RSSI Reading window the "measuring mode" shall be set on **Sum vector** and the "reading mode" on **Continuous**.

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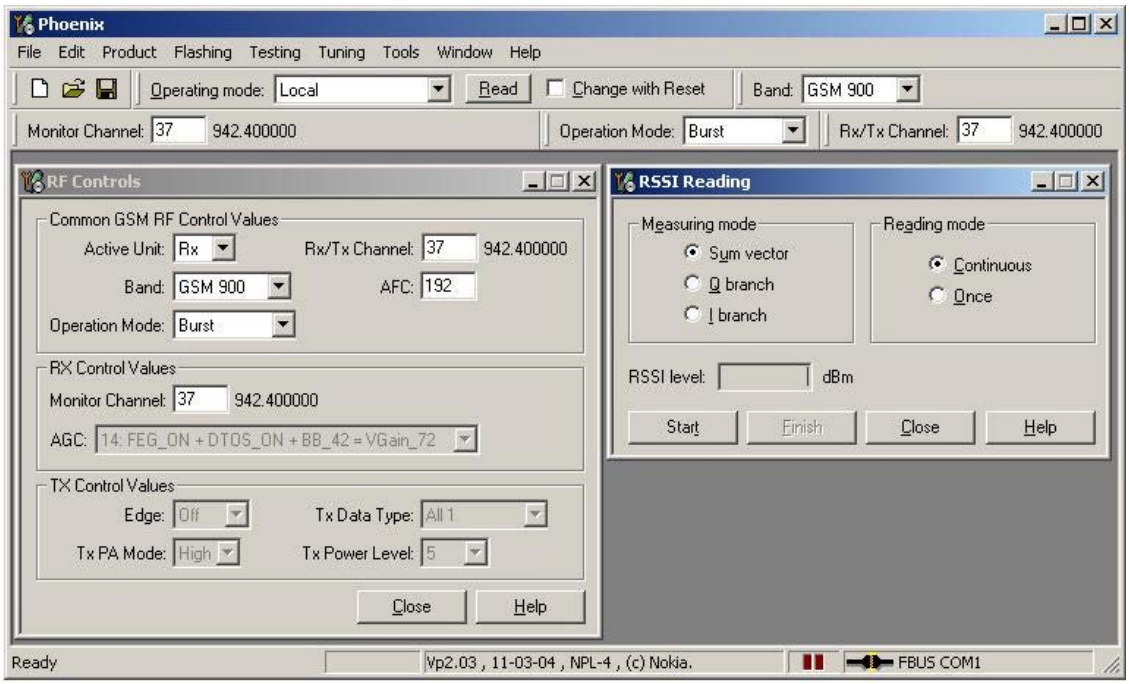
The set up should now look like this:

Figure 8: RSSI Window



- Make the following settings on your signal generator:

Frequencies:

- GSM 850: 869.26771 MHz (channel 190 + 67.710 kHz offset)
- GSM 900: 942.46771 MHz (channel 37 + 67.710 kHz offset)
- GSM 1800: 1842.86771 MHz (channel 700 + 67.710 kHz offset)
- GSM 1900: 1960.06771 MHz (channel 661 + 67.710 kHz offset)

2. RF power level:

– 60 dBm @ the antenna connector of the phone/ test jig

(Remember to compensate for the cable and jig attenuation).

- Click on "Read now" in RSSI reading.

The resulting RSSI level shall be – 60 dBm +/– 0.5 dB in each band.

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Measuring RX performance using SNR measurement

- Start Phoenix Service Software and open FBUS connection.

- Select → Scan Product (Ctrl-R)

Wait until phone information is shown in the lower right corner of the screen.

- Set operating mode to "local mode".

- Select → Testing → RF Controls

- Select → Band → GSM 850 or GSM 900 or GSM1800 or GSM1900

Active unit → RX

Operation mode →Burst

RX/TX Channel → 190 or 37 or 700 or 661

- Select → Testing → SNR Measurement

- Select → Measuring mode → Fast SNR (Radio Button)
- Press → Start

The window "Signal Measurement" pops up informing on frequency and power level of the signal generator to be set.

- Press "ok" and the window will close.

- Read the SNR results.

The values should exceed:

- GSM 850: > 20 dB
- GSM 900: > 20 dB
- GSM 1800: > 18 dB
- GSM 1900: > 18 dB

The set up should now look like this:

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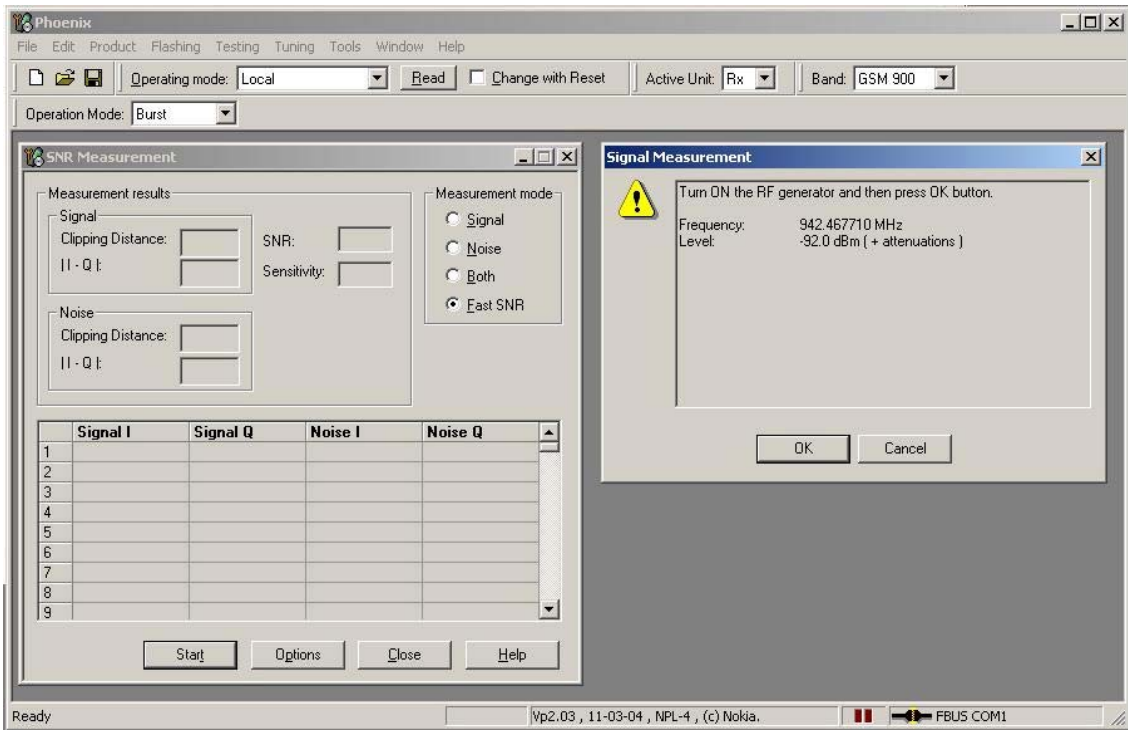
Figure 9: Signal Measurement



- Choose the remaining GSM bands and measure accordingly the procedure described above.

Measuring front-end power levels using spectrum analyzer

Spectrum Analyzer (SA) level values depend on the probe type and shall be verified by a properly working phone sample.

- Start Phoenix Service Software and open FBUS connection.

- Select → Scan Product (Ctrl-R)

Wait until phone information is shown in the lower right corner of the screen.

- Set operating mode to "local mode"

- Select → Testing → RF Controls
- Select → Band → GSM850 or GSM 900 or GSM1800 or GSM1900

Active unit → RX

Operation mode → Continuous

RX/TX Channel → 190 or 37 or 700 or 661

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Measuring analogue RX I/Q signals using oscilloscope

Measuring with an oscilloscope on "RXIINN", (**R421**) or "RXQINN", (**R423**) is recommended only if RSSI reading does not provide enough information. Input level = -60dBm.

- Start Phoenix Service Software and open FBUS connection.

- Select → Scan Product (Ctrl-R)

Wait until phone information is shown in the lower right corner of the screen.

- Set operating mode to "local mode"

- Select → Testing → RF Controls

Wait until the RF Controls window is popped up.

- Select → Band →GSM 850 or GSM 900 or GSM1800 or GSM1900

Active unit → RX

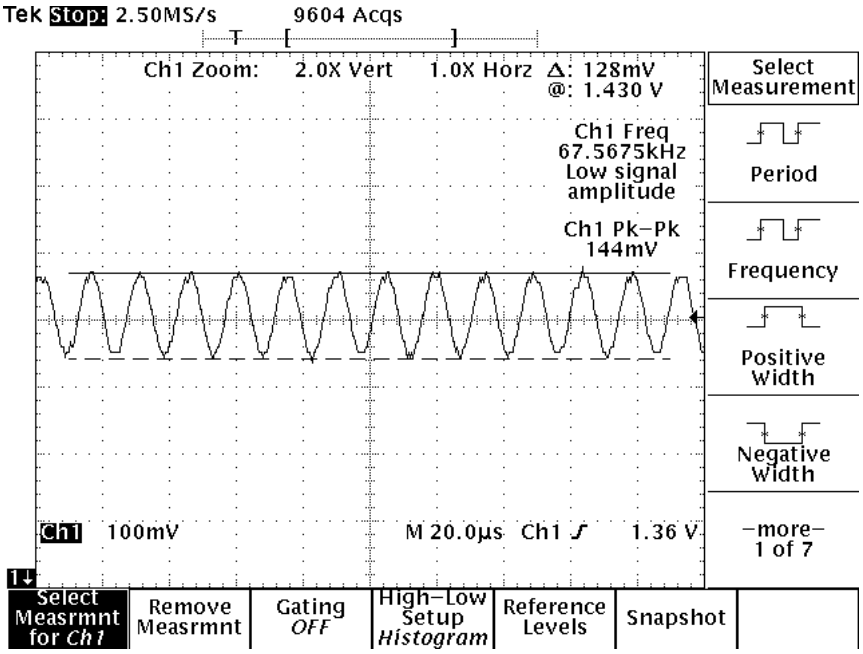
Operation mode → **continuous**

RX/TX Channel → 190 or 37 or 700 or 661

AGC → 12

Following diagram should be displayed on an oscilloscope' s screen if the GSM 900 receiver is working properly:

Figure 10: Signal Amplitudes



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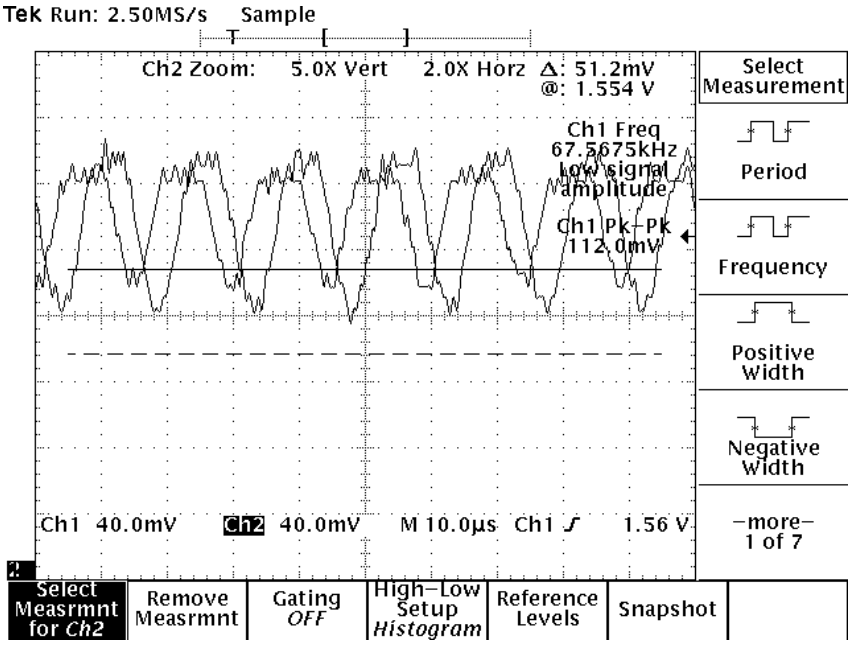
Correct signal amplitudes approximately

GSM850/900: ~140-150mVpp

GSM1800/1900: ~130-150mVpp

Signal frequency 67.7kHz

Figure 11: RX IQ Signals



RX I/Q, phase difference 90 degrees between signals.

RX I/Q-signals measured from R423 (Q-signal), R421 (I-signal) simultaneously.

Used channel 37, input signal 942.467 MHz, level –60 dBm at antenna port, AGC setting 12.

Phase difference should be 90 degrees between RX I/Q-signals at all bands.

Fault finding chart of the receiver

During fault finding, the calibration procedure is used to find out, whether all bands are affected (error in common part of the Rx chain) or only one band (error in a Rx part of the failed band). **Take care not to save calibration values to the phone memory, which are out of limits. Find the error first and repair it.**

When a defective phone has been calibrated, a possible error in RX front-end might be masked. In that case one can get a reasonable RSSI reading, although the front-end shows excessive losses. If it is not sure that incorrect re-calibration has been made, following steps shall be done:

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- Check if AGC calibration is within limits

- Check if SNR reading is OK.

- Use an Oscilloscope to check levels of "RXI" and "RXQ".

The RF ASIC generates only single ended I and Q signals (RXI, RXQ). As the A/D converter in UEM requires two differential signals, an artificial mid voltage is generated from VrefRF02.

The BB part is used to measure those signals by means of RSSI reading. This works only if correct calibration has been carried out in production.

RSSIreading [dBm] = $20\log(U_{BB}/U_{LSB})$ - $AGC_{calibrated}$

If both RX *and* TX path seem to be faulty it has to be checked if the synthesizer is working.

Figure 12: Receiver Fault Chart 1

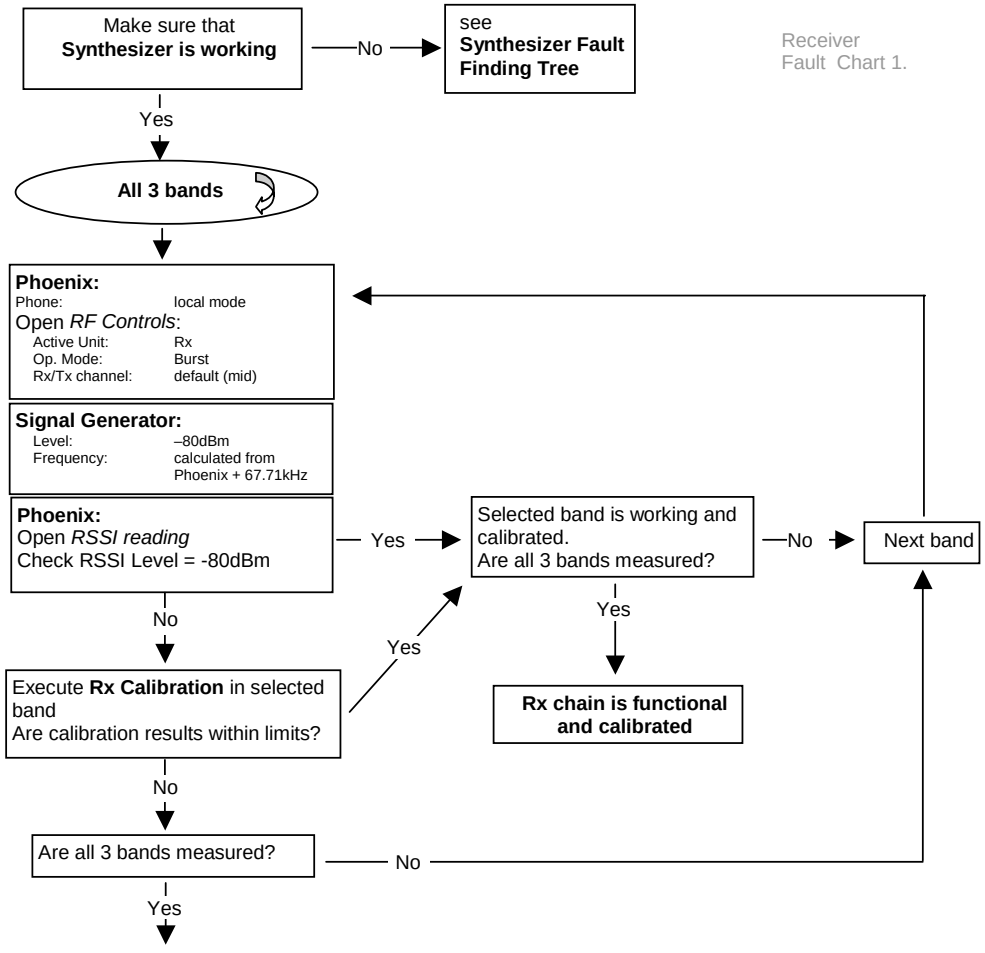

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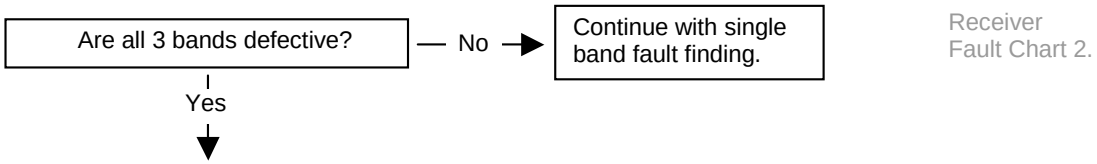
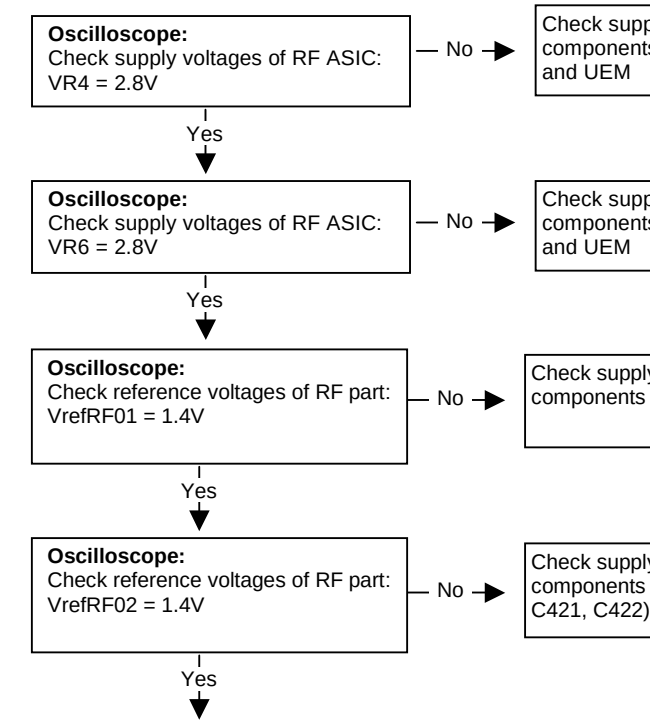
Figure 13: Receiver Fault Chart 2



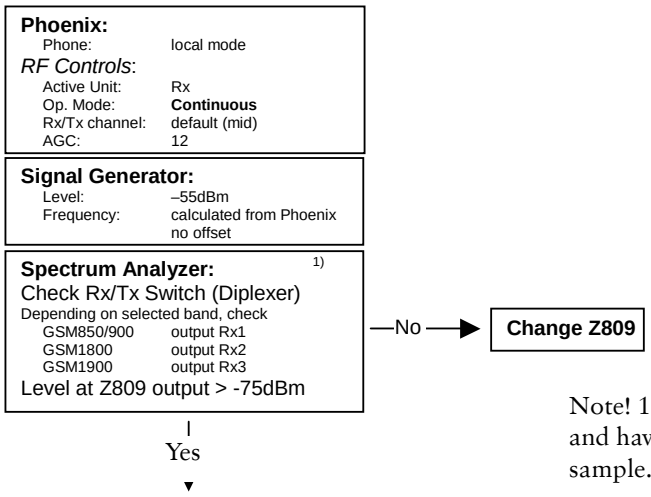
Receiver Fault Chart 2.

Figure 14: Receiver Fault Chart 3, 4, 5



Receiver Fault Chart 3.

Receiver Fault Chart 4.



Receiver Fault Chart 5.

Note! 1) RF levels are dependent on RF probe and have to be validated with a known good sample.

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Figure 15: Receiver Fault Chart 6

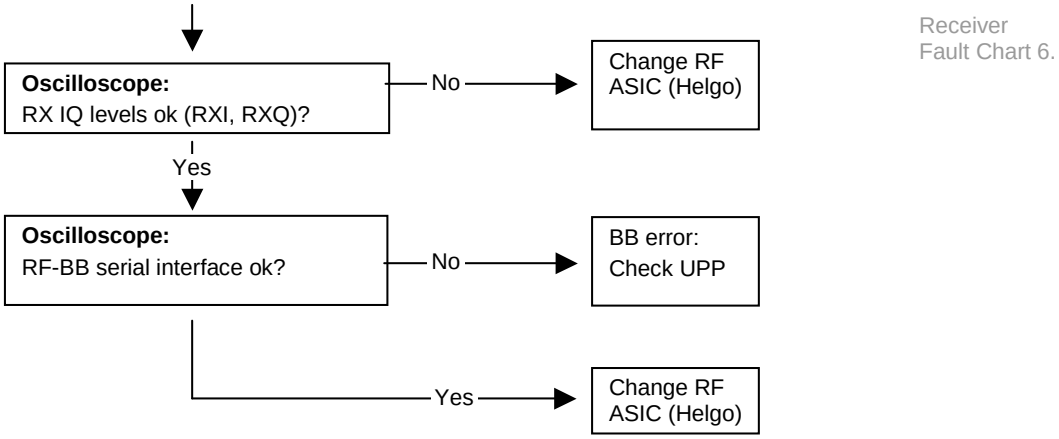

Figure 16: Receiver Fault Chart 7

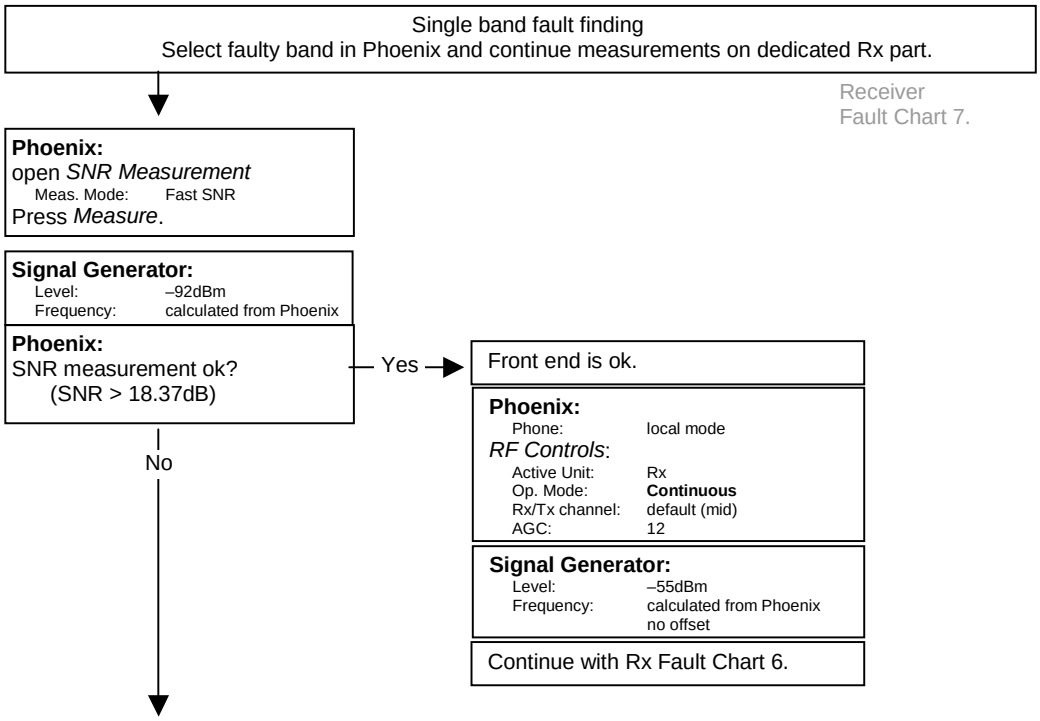

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Figure 17: Receiver Fault Chart 8

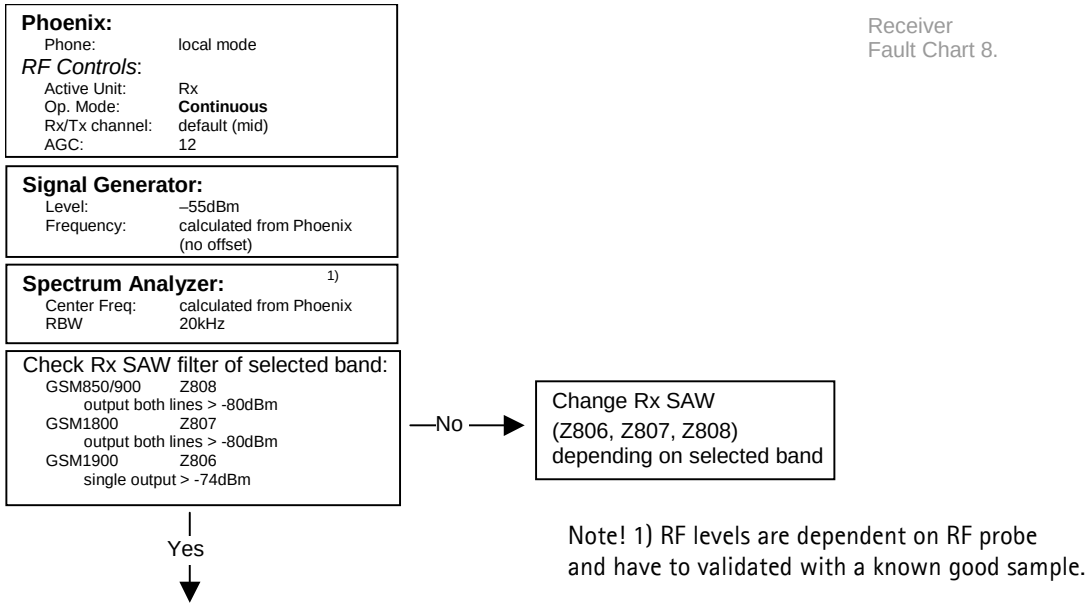
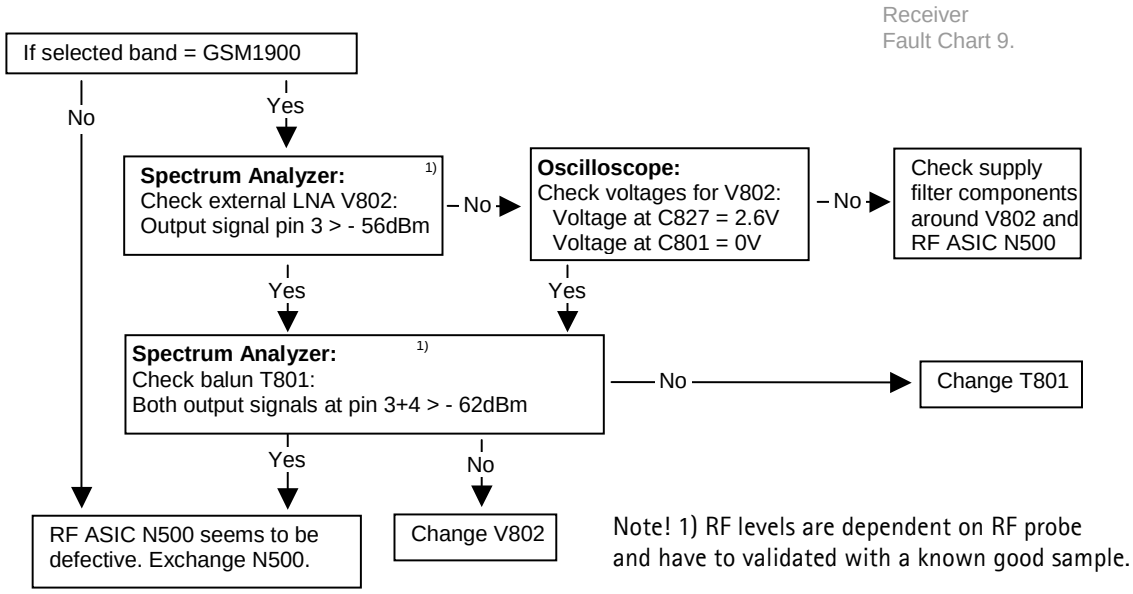


Figure 18: Receiver Fault Chart 9



Rx signal paths

Antenna switch (RX/TX switch)

RF signal is fed directly from the antenna-pad (J908) to the antenna switch (Z809).

This switch has the function of a diplexer, which consists of two combined paths (low pass/high pass filter combination), a GSM850/900 and a GSM1800/1900 path. The GSM 850/900 input signals pass the switch to the Rx1 output. Via a switch the GSM 1800 input signals pass to Rx2 output and GSM 1900 to Rx3 output, depending on the control

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signal VANT3=1, whereas VANT1=VANT2=0.

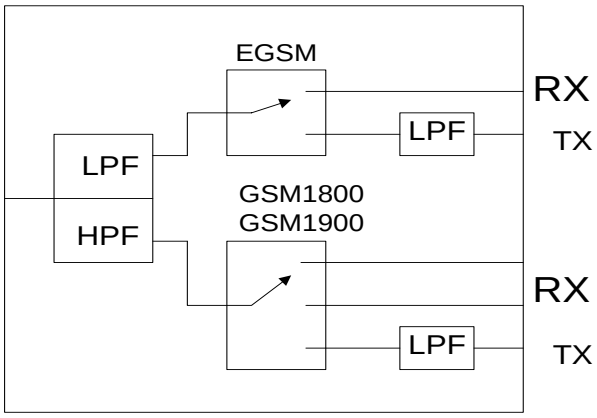
- Signal paths from the antenna switch to the band filters:
  GSM 850/900:RX1 → GSM850 SAW filter (Z808) or

  → GSM900 SAW filter (Z808)
- GSM1800: RX2 → GSM1800 SAW filter (Z807)
- GSM1900: RX3 → GSM1900 SAW filter (Z806)

The antenna switch has following typical insertion losses in Rx-mode from its input to output ports:

- GSM 850/900: 1.3 dB
- GSM 1800: 1.6 dB
- GSM 1900: 1.6 dB

Figure 19: Block Diagram of Antenna Switch: Left Input Port (Antenna) and Right Output Ports Rx/Tx



Rx front-end

The RX front-end includes three SAW filters for GSM 850 [US-variant] or GSM 900 [EU-variant] (Z808), and for both variants GSM1800 (Z807), and GSM1900 (Z806). GSM 850/900 and GSM 1800 filters are matched to the corresponding LNA inputs of the RF ASIC (N500) with differential matching network (LC-type). For GSM 1900 an external LNA (V802) improves the noise figure of the receiver. For conversion of the unbalanced output port to the balances input port of the RF ASIC the BALUN (T801) is applied, followed by a differential matching network (LC-type). The SAW filters provide the wanted out-of-band blocking immunity. They have one single-ended (unbalanced) input port and two balanced output ports each.

The SAW filters have approximately 2.5 to 3.2 dB insertion losses. The LNA for the GSM 1900 band provides a gain of approximately 17 to 20 dB.

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RX paths of RF ASIC

The balanced GSM 850/900 and GSM 1800 RX signals are amplified by one integrated LNA for each band and the subsequent pre-gain stages. The GSM 1900 signal is fed to the pre-gain stage also used for the GSM 1800 signal. After amplification the RX signals are down-converted.

The RX paths of the RF ASIC consist of following sub units:

- Separate LNAs for each of the bands: GSM 850/900, and GSM1800.
- Two PRE-GAIN amplifiers, one for GSM 850/900 and one for GSM1800 and GSM1900.
- Two passive I/Q mixers (MIX), one for GSM 850/900 and one for GSM1800 and GSM1900.

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Transmitter

General instructions for transmitter troubleshooting

Connect the phone to a PC, which has Phoenix Service Software and a dongle installed, using either

- Repair jig and DAU-9S (RS232) cable or
- DAU-9T cable (RS232) or
- DKU-5 cable (USB).

Connect the phone to a power supply (DC voltage of **3.9V**) and switch the phone on. The value of the DC voltage of 3.9V at the phone battery connector is crucial.

Attention: When repairing or tunning transmitter use external DC supply with at least 3A current capability.

Connect an RF cable between the test jig and the measurement equipment (GSM test equipment, power meter, spectrum analyzer, or similar).

Make use of an adequate attenuator at the input of your measurement equipment (10dB to 20dB are recommended for a spectrum analyzer or a power meter). Additionally, a DC block is recommended. Assure not to overload or destroy the equipment.

Start Phoenix Service Software and open FBUS connection:

Select->Scan Product->Ctrl-R

and wait until phone information is shown in the lower right corner of the screen.

Follow the instructions in the chapters below.

Transmitter troubleshooting

Antenna switch (TX/RX switch)

The antenna switch operates as a diplexer for the RX and TX signals. Moreover, it suppresses the TX harmonics generated by the PA. The antenna switch is a controlled by the RF ASIC using the control signals VANT1, VANT2 and VANT3.

The table below shows the possible different switching states.

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Table 1: Switching States

VANT2 VC1 [Volt]	VANT3 VC2 [Volt]	VANT1 VC3 [Volt]	Rx1 GSM 850/900 Rx	Rx2 GSM 1800 Rx	Rx3 GSM 1900 Rx	TX_IN_EGSM Tx1 GSM 850/900 Tx	TX_IN_DCS Tx2 GSM 1800/1900 Tx
0	0	0	X				
0	0	0		X			
0	0	2.7				X	
0	2.7	0			X		
2.7	2.7	0					X

To switch the TX -GSM 1800/1900 path both signals VANT2 and VANT3 have to be activated. This increases the isolation from the TX-GSM 1800/1900 path to the RX-GSM 1800 path and reduces the feed back of RF-power to the RF ASIC.

GSM850 transmitter

GSM850 chapture is valid only for the NPL-4 (US variant). Start the preparations as described in chapter General instruction for the transmitter troubleshooting.

General instructions for GSM850 TX troubleshooting

GMSK

Select operating mode to “local mode”:

Select->Testing->RF Controls

In the popped up window:

Select->Band->GSM 850

-Active unit->TX

-Operation mode->Burst

-RX/TX Channel->190

-TX Power Level->10

-TX Data Type->Random

The Phoenix window should now look like this:

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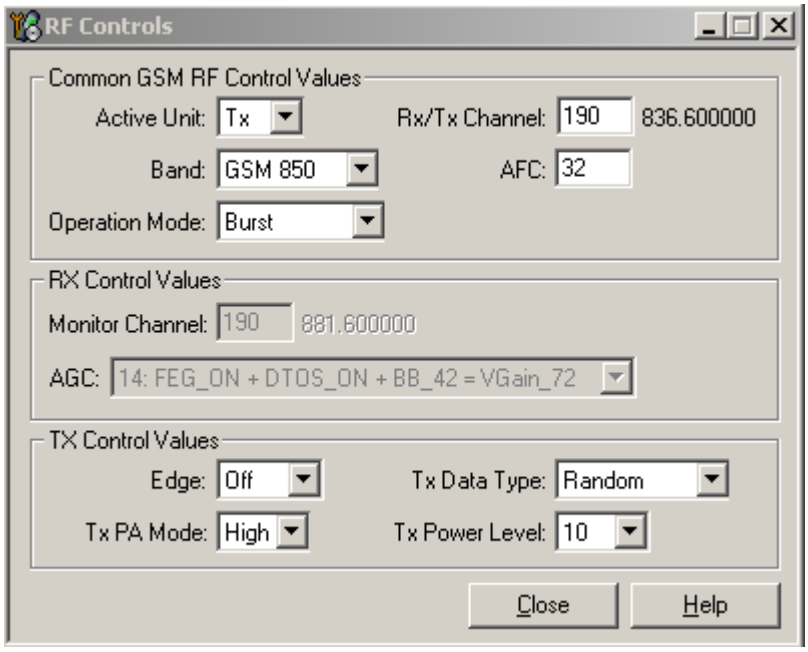
Figure 20: RF Controls



Now the measurement setup, which has been built according to the **Check synthesizer Operation**-chapter, should detect the following output signal of the phone.

P_{out} = +23dBm @ 836.6 MHz

If this is not the case, then go to the chapter **GMSK for the troubleshooting**.

Start the preparations as described in chapter **Check synthesizer Operation**.

EDGE

Select operation mode to the "local".

Select->Testing -> RF control

In the popup window common values:

Active unit:->TX

Band: ->850

Operation mode: ->Burst

RX/TX Channel:->190

In the popup window TX control values:

EDGE:->ON

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Tx data type:->Alternate

TX PA mode:->High

TX Power level:->10

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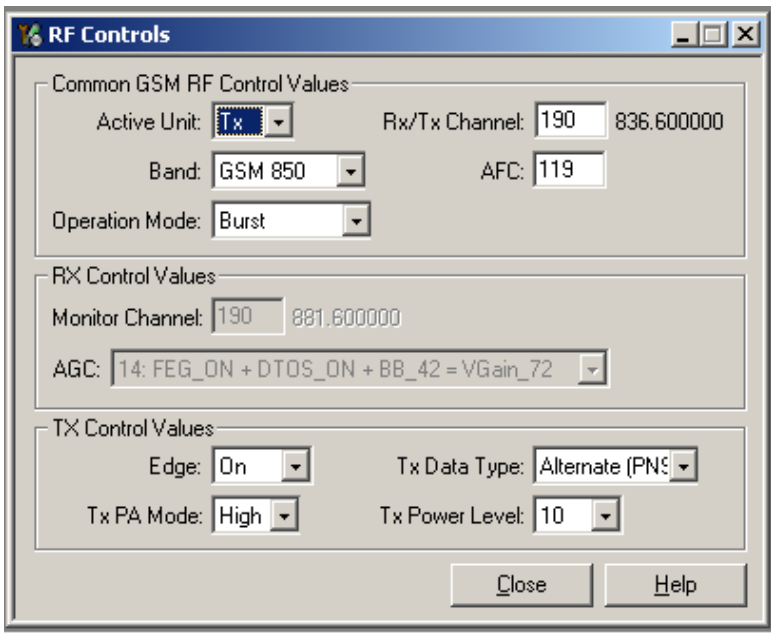
The Phoenix window should now look like this:

Figure 21: RF Controls



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +24 dBm @ 836.6 MHz

If this is not the case, then go to the chapter **EDGE for the troubleshooting**.

Start the preparations as described in **Check synthesizer Operation** .

Fault Finding Chart for GSM850 Transmitter

In the following, it is assumed that the TXP signal is used as trigger-signal. For that a TXP test point is provided.

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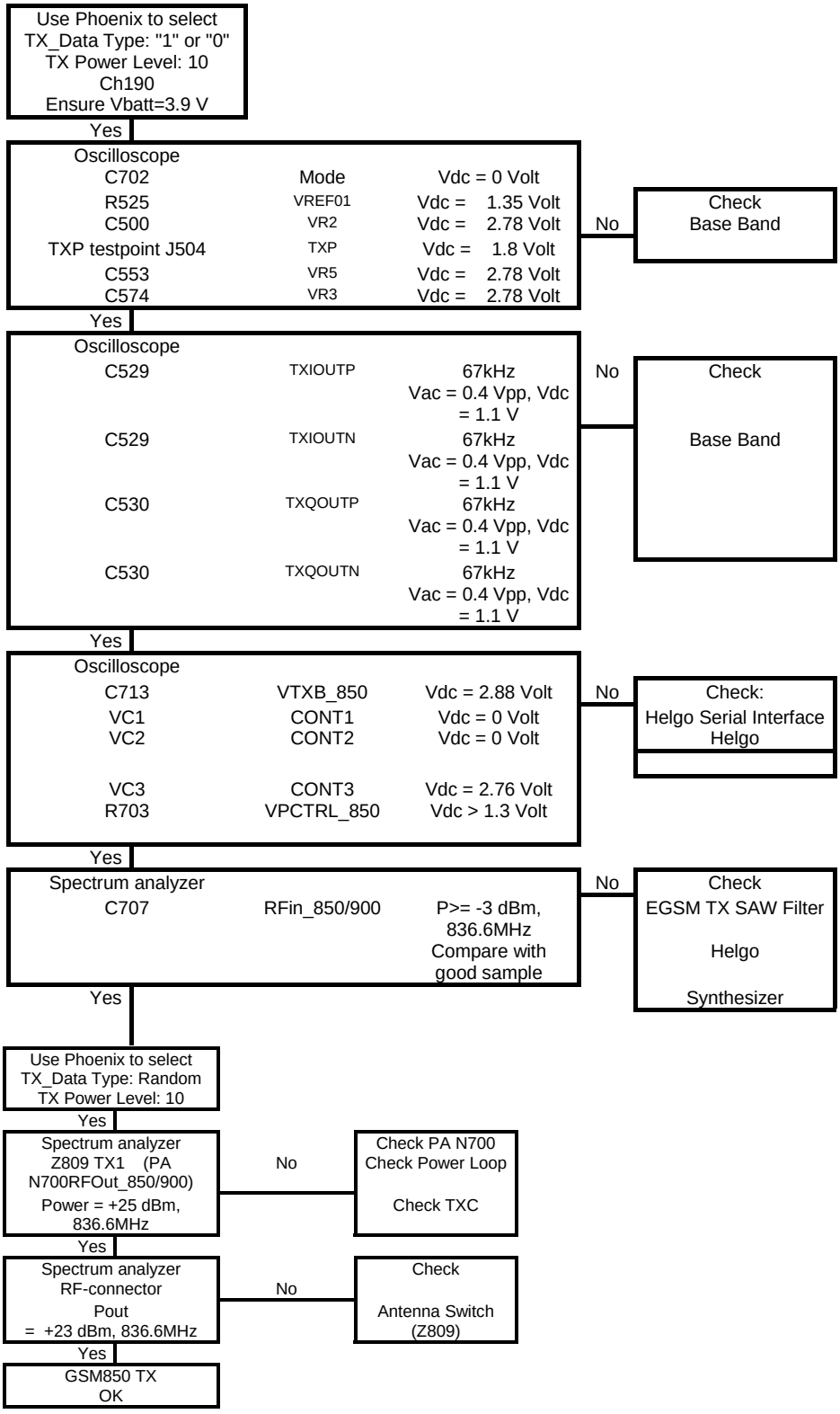
GMSK



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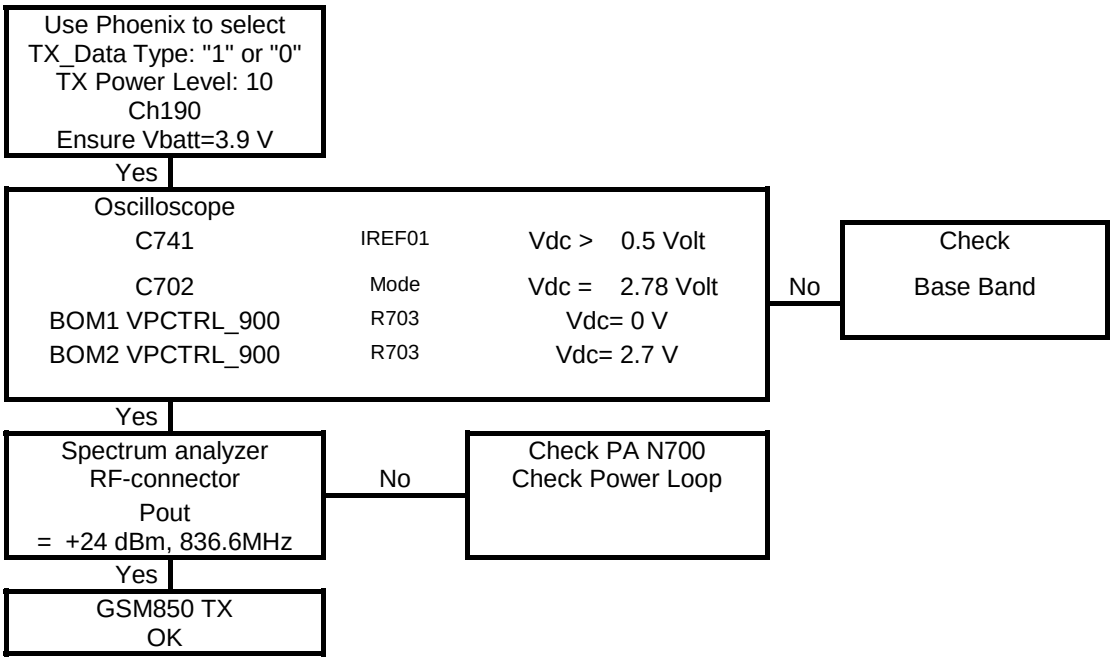
EDGE

Ensure that the GMSK is **OK**!



GSM900 transmitter

GSM900 chapter is valid only for the NPL-5 (EU variant).

General instructions for GSM TX troubleshooting

GMSK

Set the operating mode to the "local mode".

Select-<Testing->RF Controls

Wait until the RF Controls window is popped up

Select->Band->GSM 900

-Active unit->TX

-Operation mode->Burst

-RX/TX Channel->37

-TX Power Level->10

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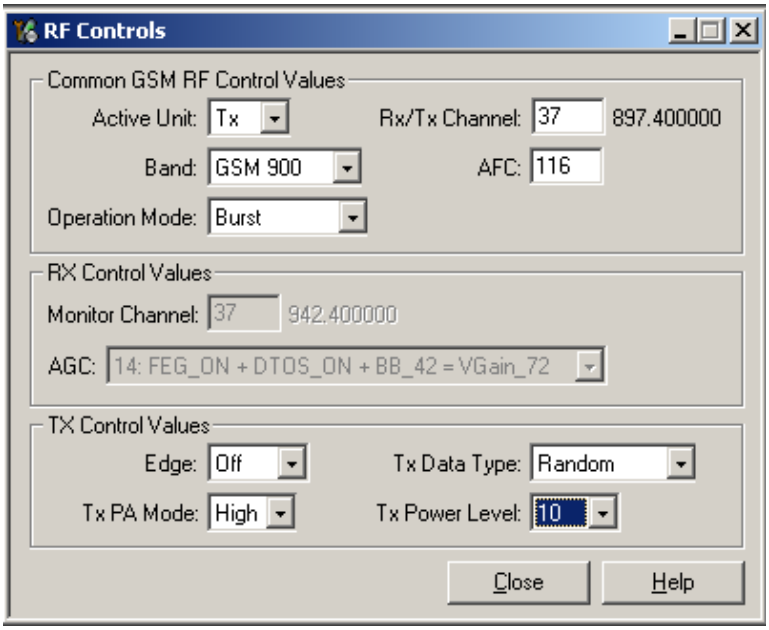
-TX Data Type->Random

The setup should now look like this:

Figure 22: Band Selection



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +23dBm @ 897.4 MHz

If this is not the case, then go to the chapter **GMSK for troubleshooting**.

EDGE

Select operation mode to the "local".

Select->Testing-> RF control

In the popup window common values:

Active unit:->TX

Band: ->900

Operation mode: ->Burst

RX/TX Channel:->37

In the popup window TX control values:

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EDGE:->ON

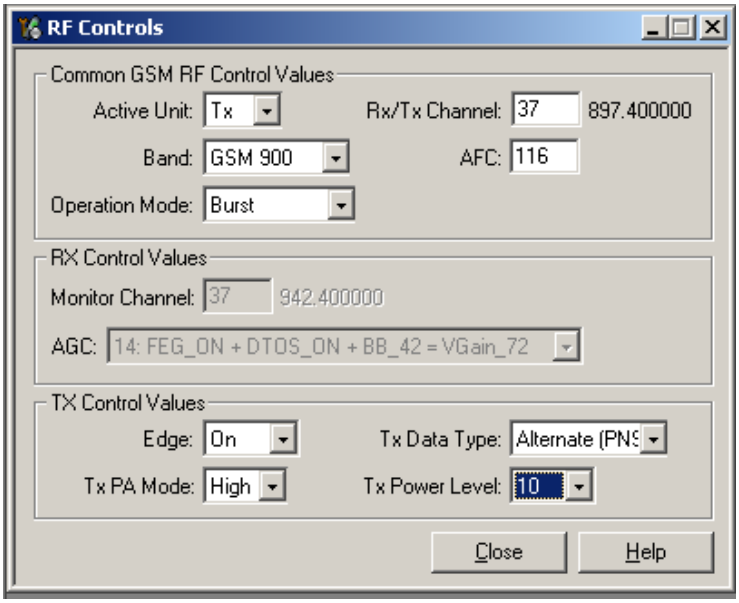
Tx data type->Alternate

TX PA mode:->High

TX Power level:->10

The setup should now look like this:

Figure 23: RF Control Values



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +24 dBm @ 897.4 MHz

If this is not the case, then go to the chapter **EDGE for the troubleshooting**.

Fault finding chart for GSM900 transmitter

In the following, it is assumed that the TXP signal is used as trigger-signal. For that a TXP test point is provided.

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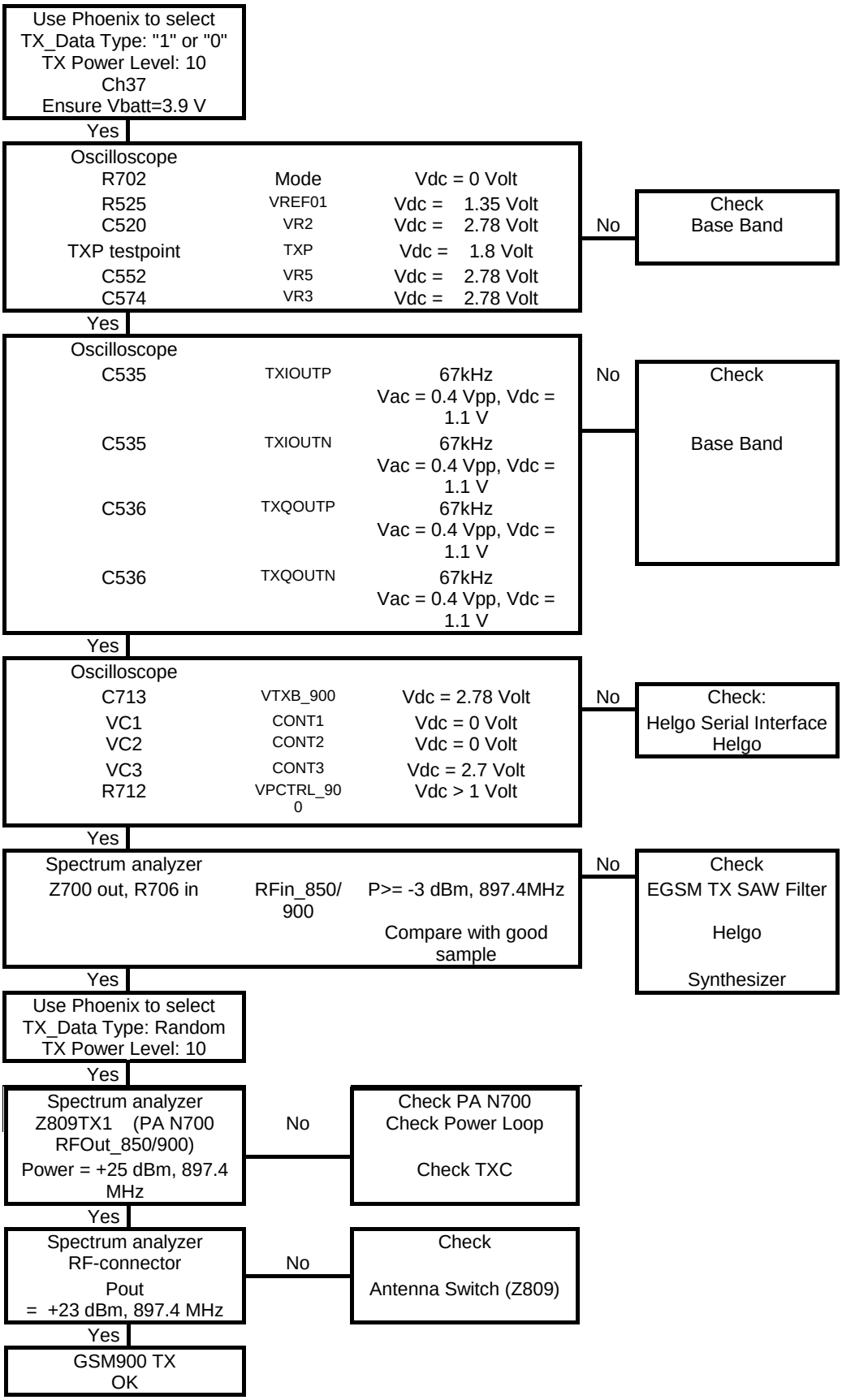
GMSK



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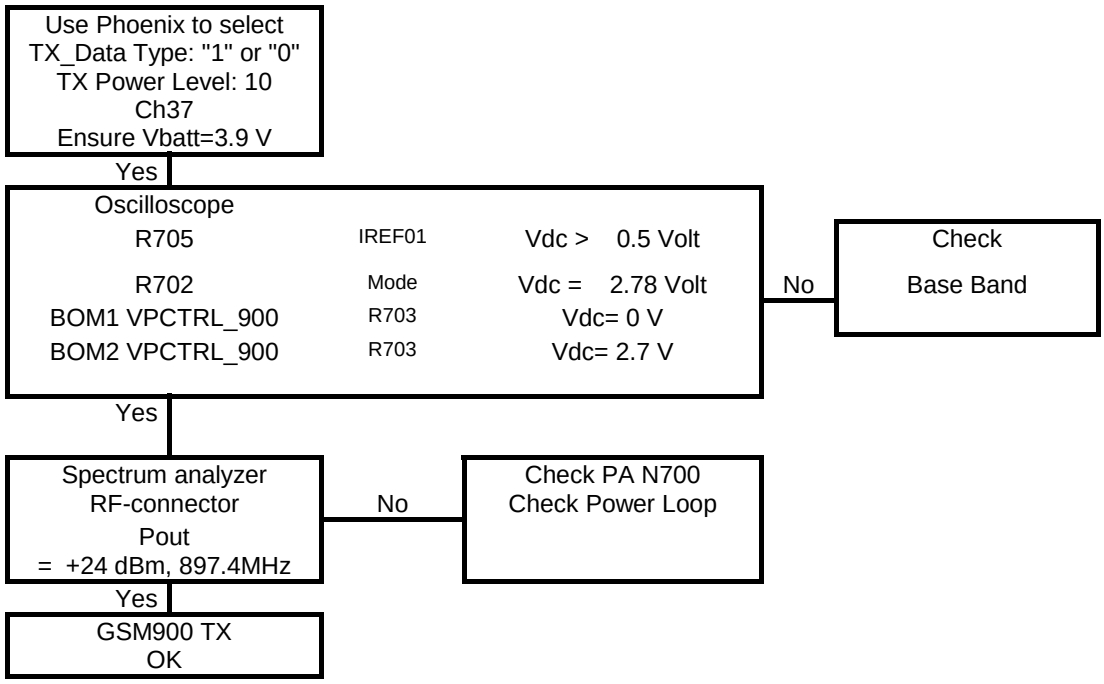
EDGE

Ensure that the GMSK is **OK!**



GSM1800 transmitter

General instructions for GSM1800 TX troubleshooting

Start the preparations as described in chapter **Check Synthesizer Operation**.

GMSK

Set the operating mode to "local mode".

Select->Testing->RF Controls

Wait until the RF Controls window is popped up

Select->Band->GSM 1800

-Active unit->TX

-Operation mode->Burst

-RX/TX Channel->700

-TX Power Level->5

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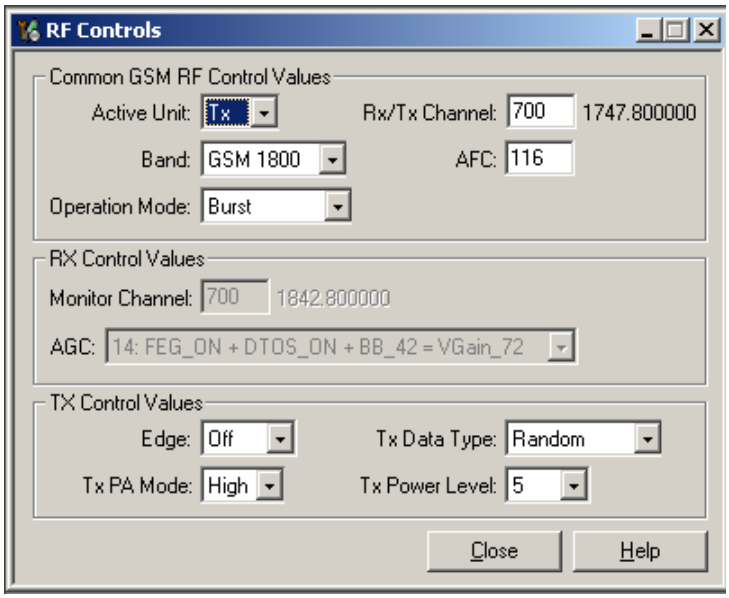
-TX Data Type->Random

The setup should now look like this:

Figure 24: RF Control Values



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +23dBm @ 1747.8 MHz

If this is not the case, then go to the chapter **GMSK for the troubleshooting**.

EDGE

Select operation mode to the "local".

Select->Testing -> RF control

In the popup window common values:

Active unit:->TX

Band:->1800

Operation mode: ->Burst

RX/TX Channel:->700

In the popup window TX control values:

EDGE:->ON

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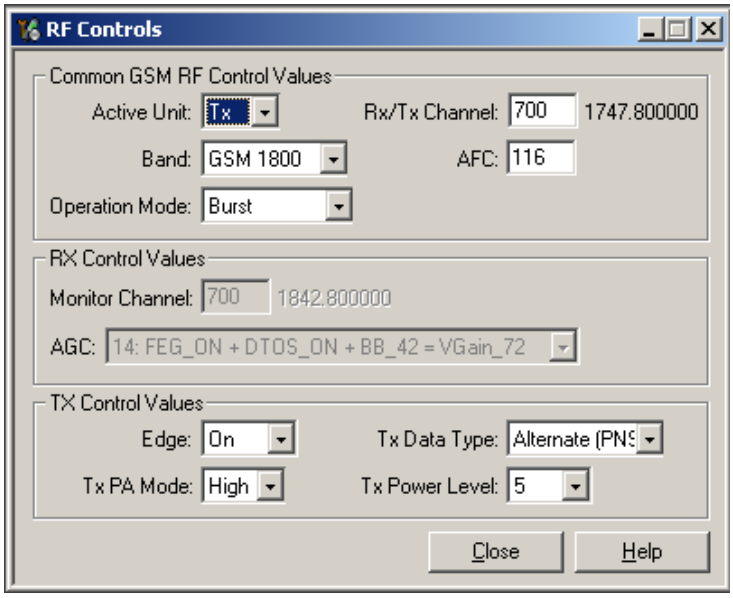
Tx data type:->Alternate

TX PA mode:->High

TX Power level:->5

The setup should now look like this:

Figure 25: RF Control Values



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +21 dBm @ 1747.8 MHz

If this is not the case, then go to the next chapter for troubleshooting.

Fault finding chart for GSM1800 transmitter

In the following, it is assumed that the TXP signal is used as trigger-signal. For that a TXP test point is provided.

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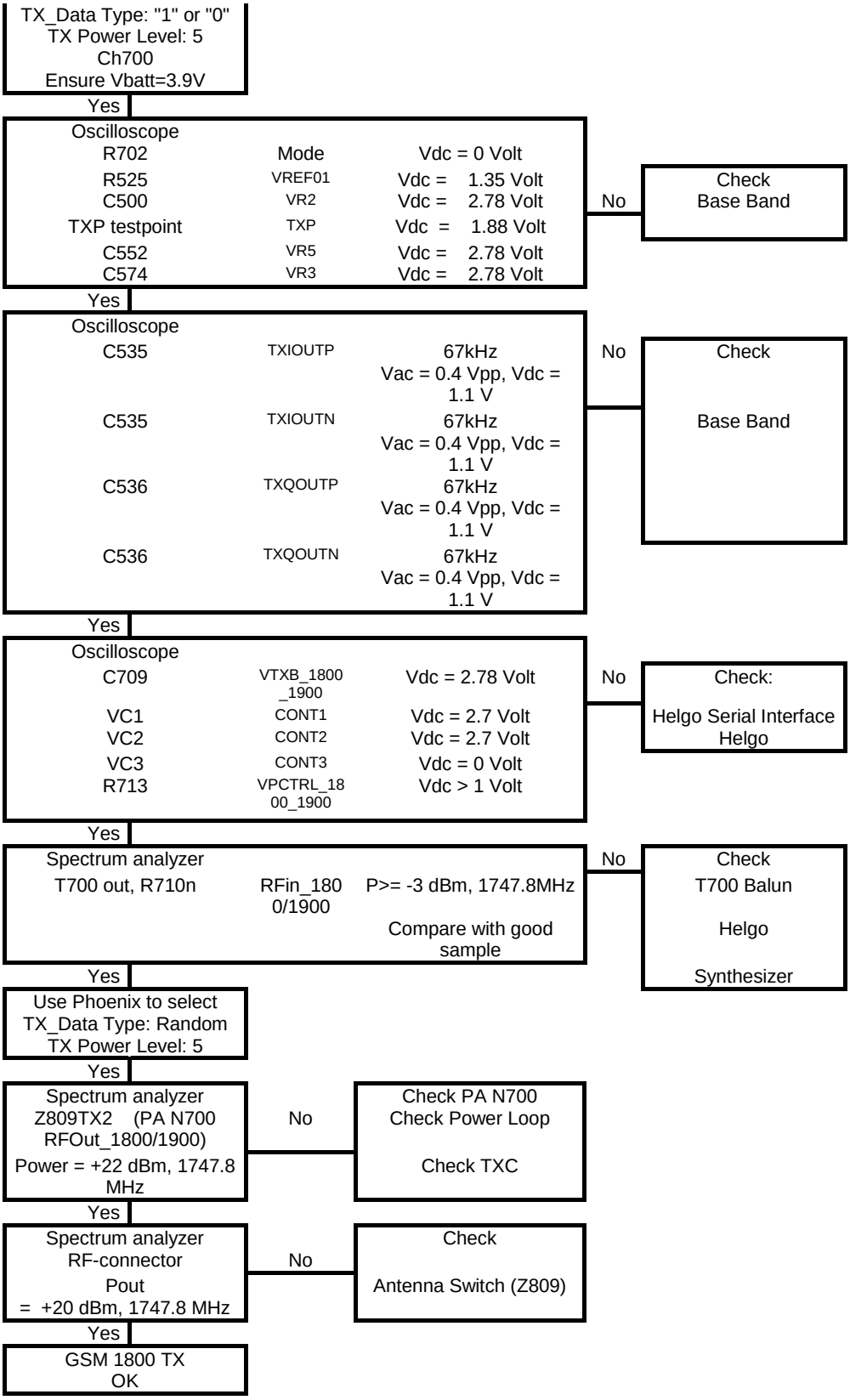
GMSK



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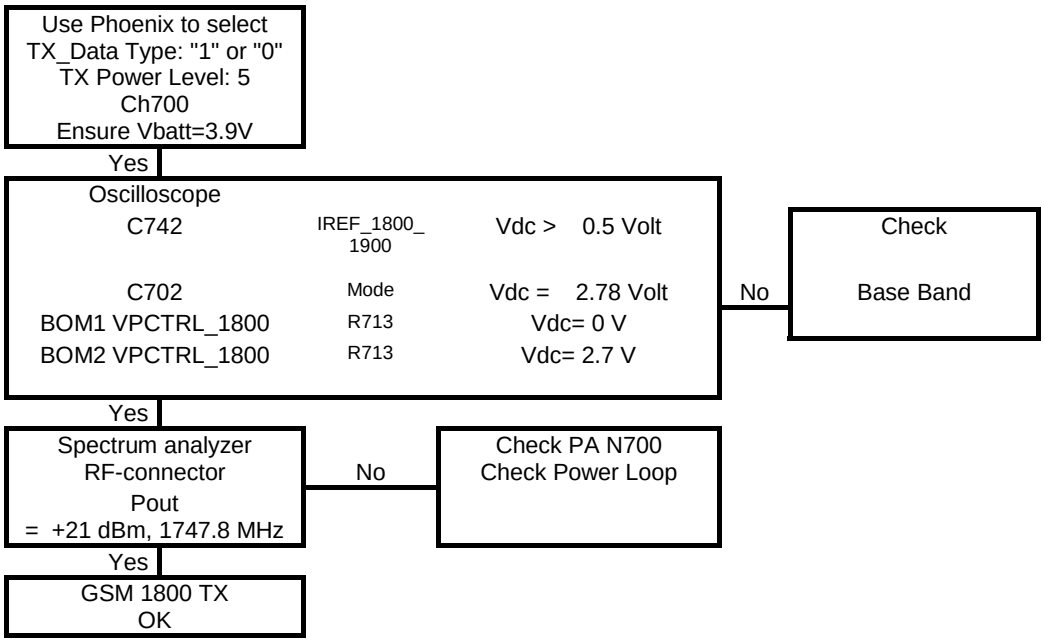
EDGE

Ensure that the GMSK is **OK!**



GSM1900 transmitter

General instructions for GSM1900 TX troubleshooting

GMSK

Set the operating mode to "local mode".

Select->Testing->RF Controls

Wait until the RF Controls window is popped up

Select->Band->GSM 1900

-Active unit->TX

-Operation mode->Burst

-RX/TX Channel->661

-TX Power Level->5

-TX Data Type->Random

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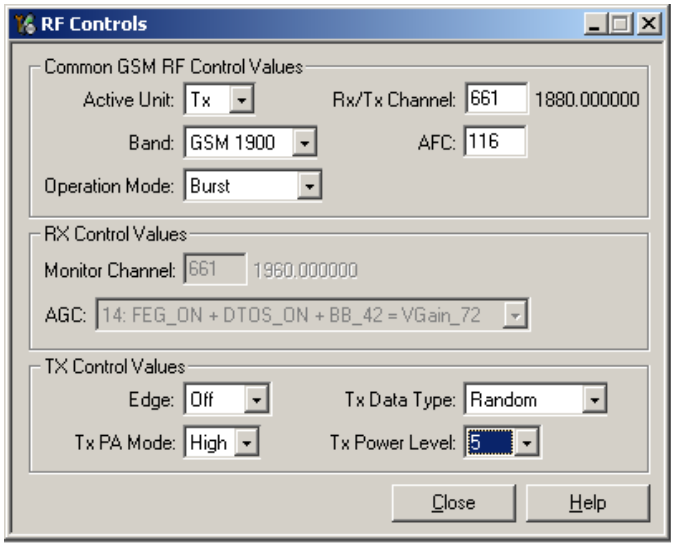
The setup should now look like this:

Figure 26: RF Control Values



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +23dBm @ 1880 MHz

If this is not the case, then go to the chapter **GMSK for the troubleshooting**.

EDGE

Select operation mode to the "local".

Select->Testing -> RF control

In the popup window common values:

Active unit:->TX

Band: ->1900

Operation mode: ->Burst

RX/TX Channel:->661

In the popup window TX control values:

EDGE:->ON

Tx data type:->Alternate

TX PA mode:->High

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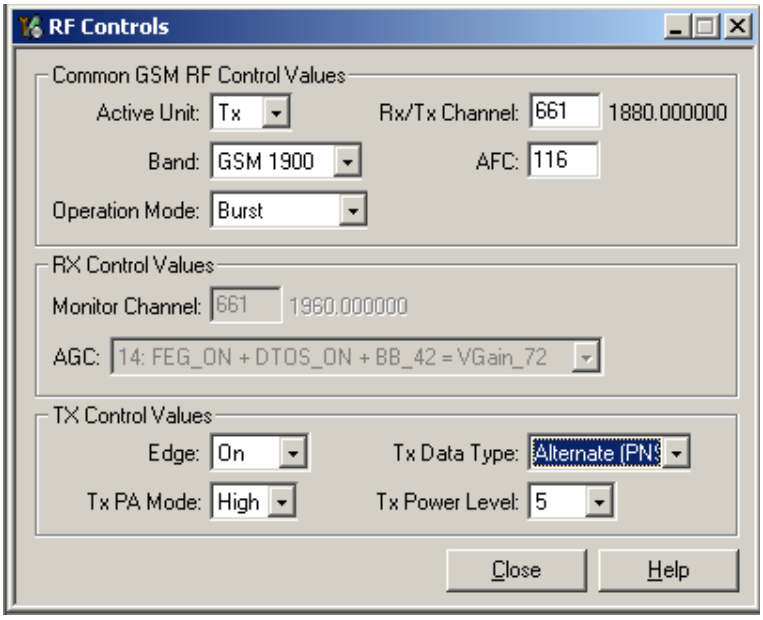
TX Power level:->5

The setup should now look like this:

Figure 27: RF Control Values



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +21 dBm @ 1880 MHz

If this is not the case, then go to the chapter **EDGE for the troubleshooting**.

Fault finding chart for GSM1900 transmitter

In the following, it is assumed that the TXP signal is used as trigger-signal. For that a TXP test point is provided.

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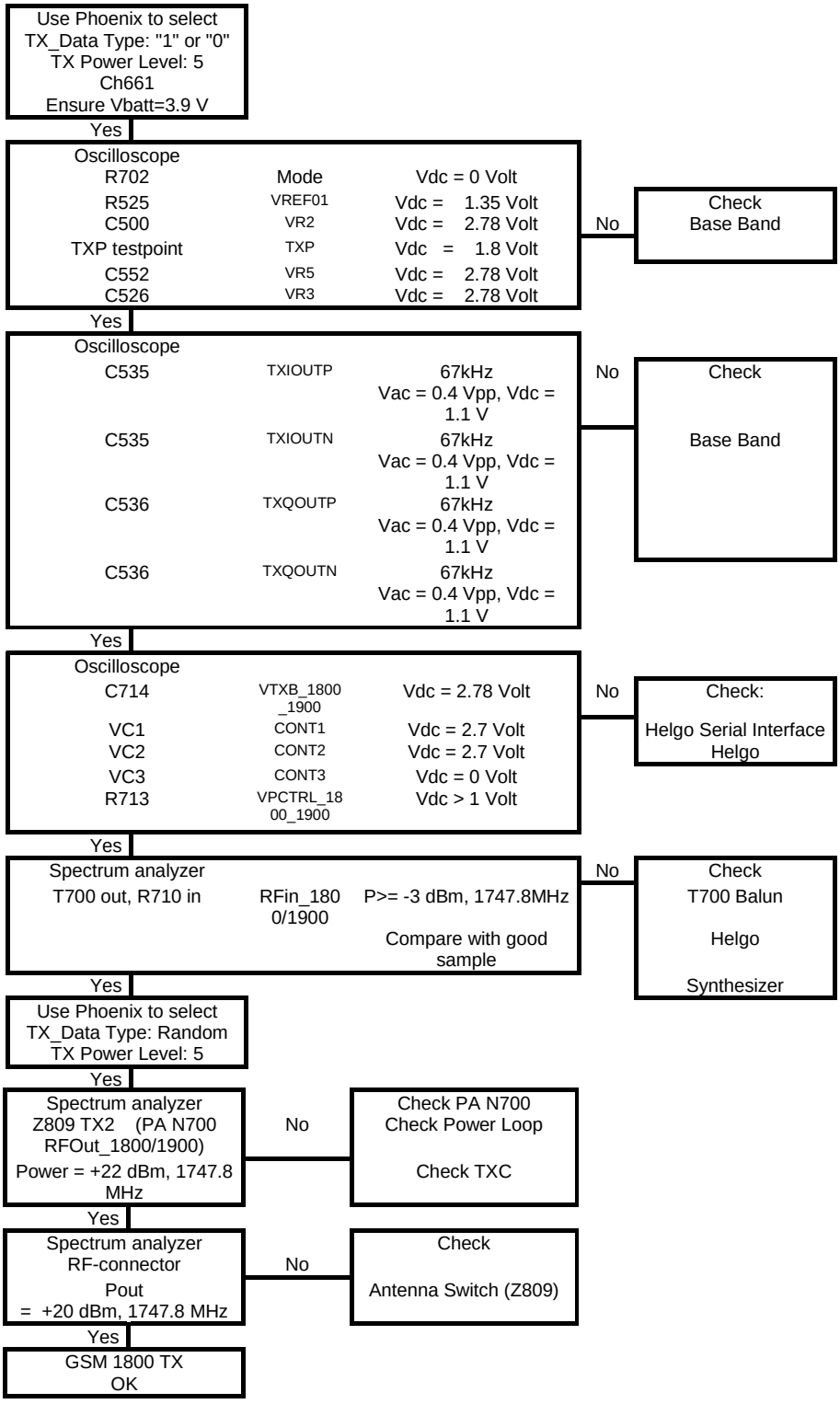
GMSK



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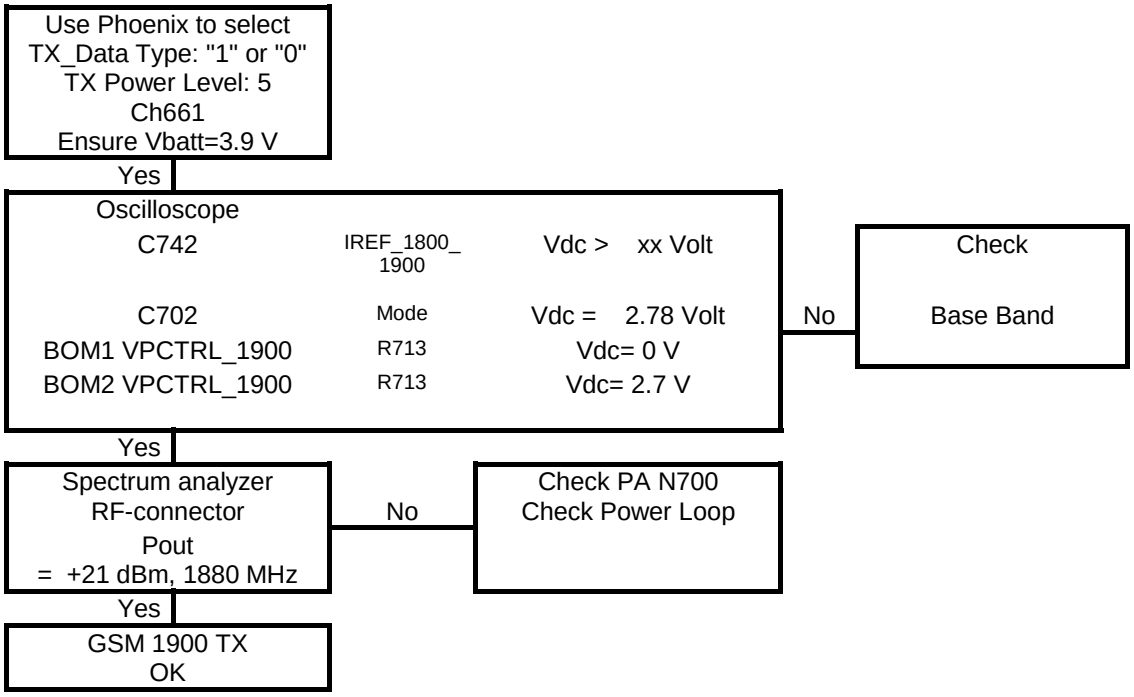
EDGE

Ensure that the GMSK is **OK!**



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Synthesizer

Check synthesizer operation

Start Phoenix Service Software and open FBUS connection.

Select "Scan Product" (Ctrl-R or in menu File - Scan Product).

Wait until phone information is shown in the lower right corner of the screen.
Set "operating mode" to "Local".

Open window "RF Controls" (menu Testing - RF Controls)

Set the synthesizer to the following mode:

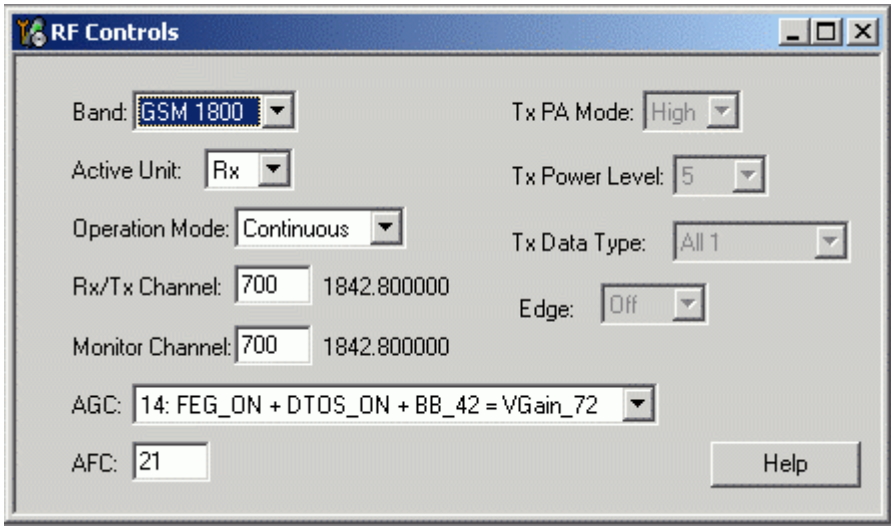
Select->Band->GSM 1800

-Active unit->RX

-Operation mode->Continuous

-RX/TX Channel->700

The setup should now look like this:



To measure the supply voltage VR7, the tuning voltage Vc and the output frequency $f_{VCO;}$ see Figure : Test points of the synthesizer.

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The VCO frequency is twice the Rx frequency in the GSM1800 band:

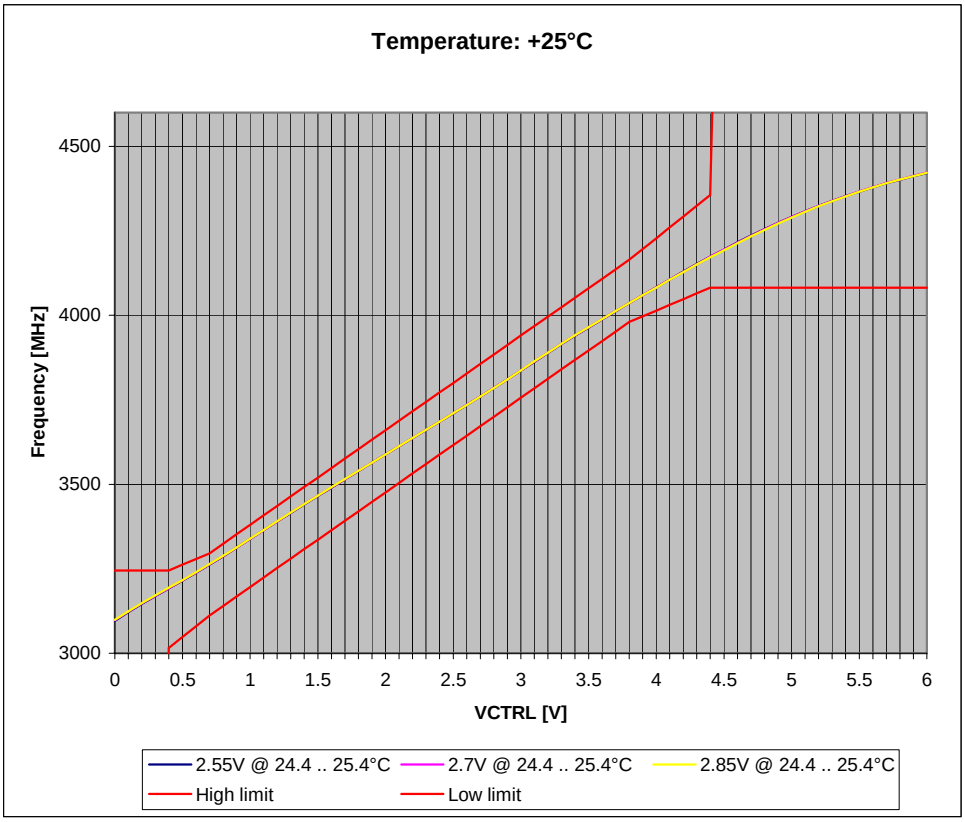
f_{VCO} = 2 * f_{RX} = 2 * 1842.8 MHz = **3685.6 MHz**. The VCO frequency shall be measured at VCO output.

The tuning voltage can be easily measured at the Vc input of the VCO. The voltage shall be measured at C503.

The tuning voltage should be **2.1V_{DC} .. 2.6V_{DC}** at f_{VCO} = 3685.6MHz.

The tuning sensitivity of the VCO is typically 250MHz/V. The typical relation of VCO frequency and tuning voltage is shown in the following diagram:

Figure 28: Typical Feature Tuning Curve for the Matshushita VCO



If the frequency or the tuning voltage have other values than given above, then go to chapter **Fault finding chart for PLL synthesizer**.

Reference oscillator 26 MHz (VCTCXO)

The reference oscillator is implemented as Voltage Controlled Temperature Compensated Crystal Oscillator (VCTCXO) module. The component (G501) is located in the Small Signal chamber.

The reference oscillator has two functions:

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- Reference frequency for the PLL synthesizer.
- System clock for BB (signal VCTCXO = 26 MHz, output REFOUT of the Helgo ASIC N500).

For an error free initial synchronization, the 26MHz frequency of the reference oscillator must be accurate enough. Therefore, an analog voltage with signal name AFC tunes the oscillator.

The AFC voltage is calculated using the values "AFC value" and "AFC slope", which are determined during Rx calibration of the low band.

Voltage Controlled Oscillator (VCO)

The VCO is able to generate frequencies in the range of 3296MHz to 3980MHz when the PLL is working properly. The frequency of the VCO signal is divided by 2 or by 4 in the RF-ASIC. This allows the generation of all the frequencies in the GSM850, GSM900, GSM1800 and GSM1900 bands, both RX and TX range.

The output frequency of the VCO is controlled by a DC voltage (Vc) of the PLL loop filter. The valid range of Vc is 0.7V– 3.8V when the PLL is in steady state. The typical tuning sensitivity is 250MHz/V.

Even if the PLL is not working properly (Vc outside the valid range), a frequency at the output of the VCO can be detected between 3GHz and 4.4 GHz (if the VCO itself is ok and the supply voltage VR7 = 2.78V is available).

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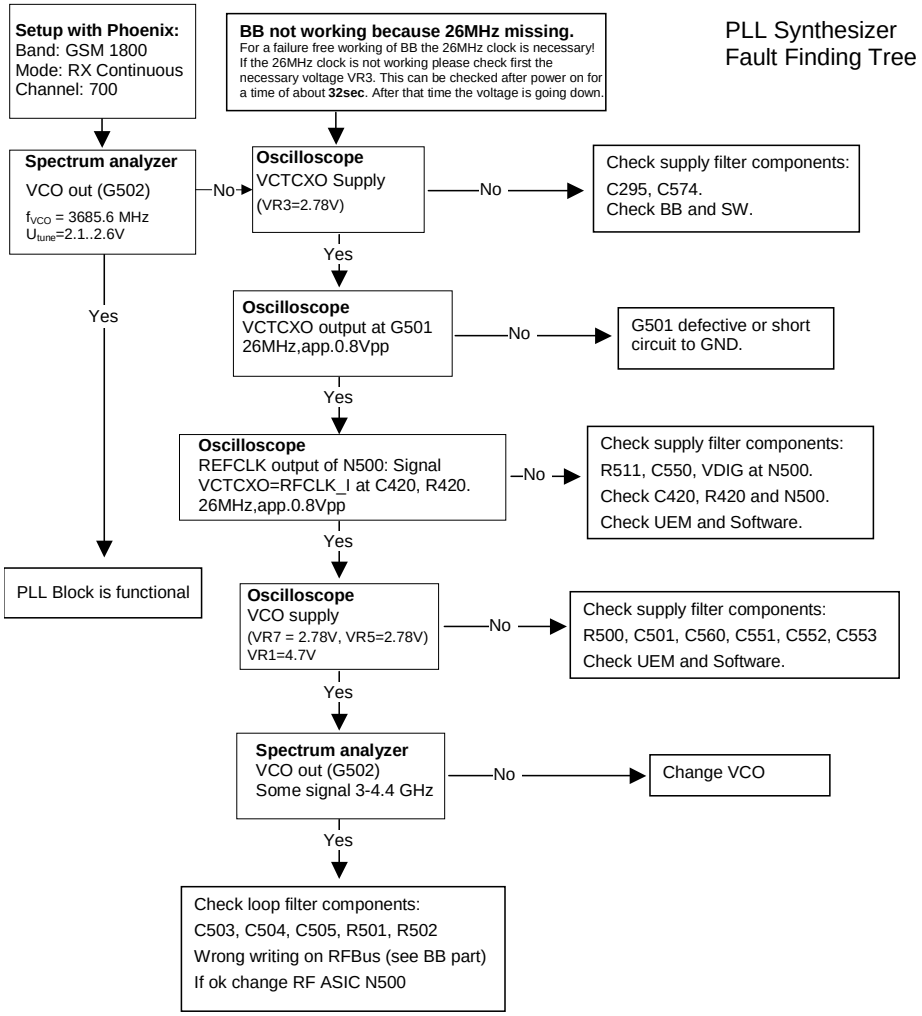
Fault finding chart for PLL synthesizer



It is important to note that the power supply VR3 of the VCTCXO is only switched off in the so-called 'Deep Sleep Mode' and the power supply VR7 of the VCO (G502) is switched off in so-called 'Sleep Mode'.

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Pictures of synthesizer signals

Figure 29: 26 Mhz at G501 Pin Out

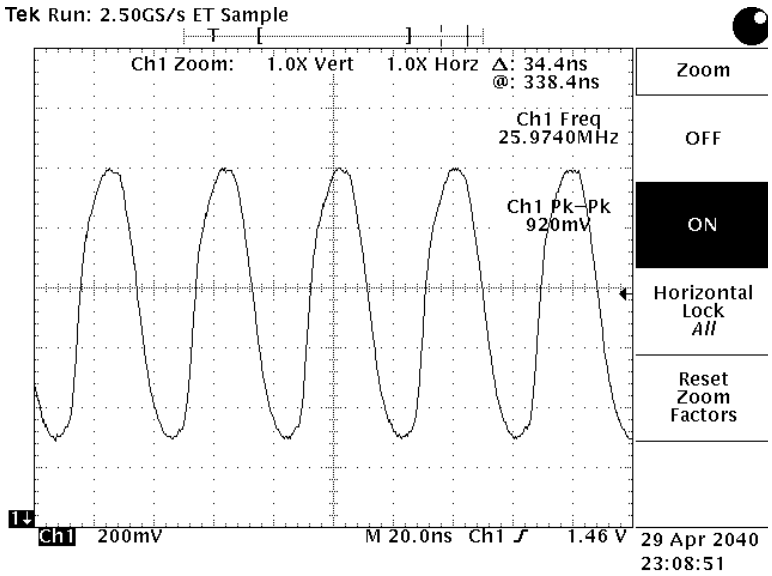

Figure 30: 26 MHz RFCLK at R420/C420

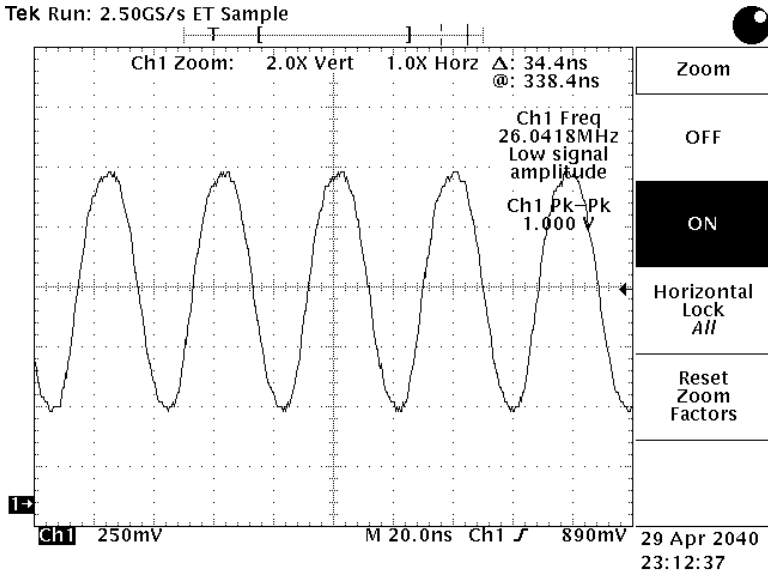

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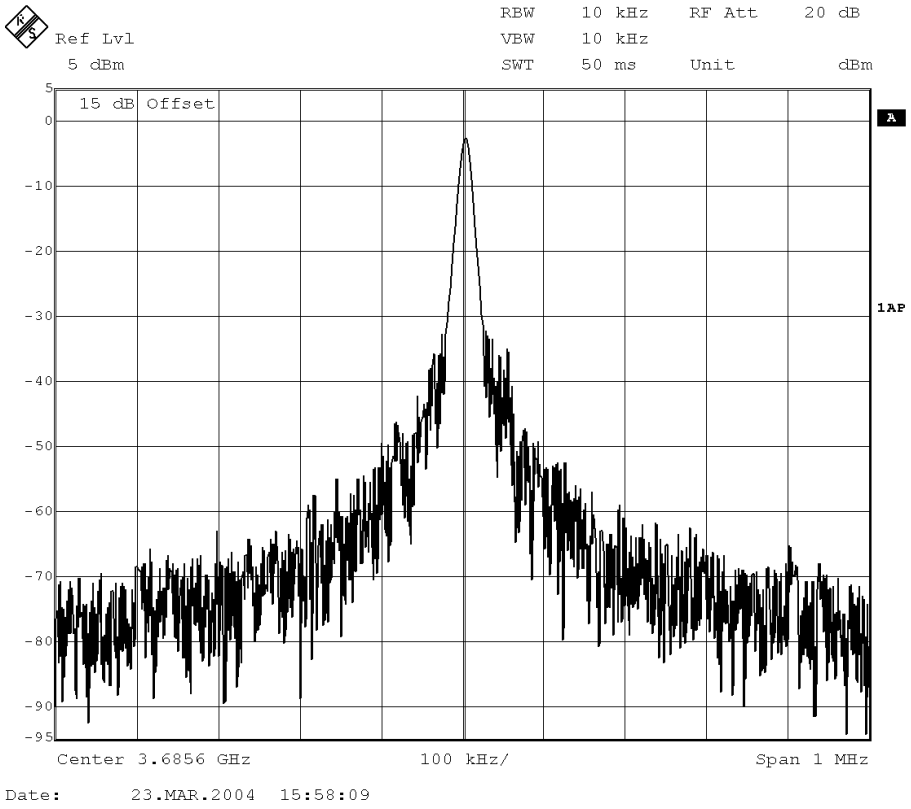
Figure 31: VCO Output, 1800 Band, RX on, Continuous Output



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Frequency tables

GSM850

Frequency list GSM850									
CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
128	824.2	869.2	3296.8	3476.8	190	836.6	881.6	3346.4	3526.4
129	824.4	869.4	3297.6	3477.6	191	836.8	881.8	3347.2	3527.2
130	824.6	869.6	3298.4	3478.4	192	837.0	882.0	3348.0	3528.0
131	824.8	869.8	3299.2	3479.2	193	837.2	882.2	3348.8	3528.8
132	825.0	870.0	3300.0	3480.0	194	837.4	882.4	3349.6	3529.6
133	825.2	870.2	3300.8	3480.8	195	837.6	882.6	3350.4	3530.4
134	825.4	870.4	3301.6	3481.6	196	837.8	882.8	3351.2	3531.2
135	825.6	870.6	3302.4	3482.4	197	838.0	883.0	3352.0	3532.0
136	825.8	870.8	3303.2	3483.2	198	838.2	883.2	3352.8	3532.8
137	826.0	871.0	3304.0	3484.0	199	838.4	883.4	3353.6	3533.6
138	826.2	871.2	3304.8	3484.8	200	838.6	883.6	3354.4	3534.4
139	826.4	871.4	3305.6	3485.6	201	838.8	883.8	3355.2	3535.2
140	826.6	871.6	3306.4	3486.4	202	839.0	884.0	3356.0	3536.0
141	826.8	871.8	3307.2	3487.2	203	839.2	884.2	3356.8	3536.8
142	827.0	872.0	3308.0	3488.0	204	839.4	884.4	3357.6	3537.6
143	827.2	872.2	3308.8	3488.8	205	839.6	884.6	3358.4	3538.4
144	827.4	872.4	3309.6	3489.6	206	839.8	884.8	3359.2	3539.2
145	827.6	872.6	3310.4	3490.4	207	840.0	885.0	3360.0	3540.0
146	827.8	872.8	3311.2	3491.2	208	840.2	885.2	3360.8	3540.8
147	828.0	873.0	3312.0	3492.0	209	840.4	885.4	3361.6	3541.6
148	828.2	873.2	3312.8	3492.8	210	840.6	885.6	3362.4	3542.4
149	828.4	873.4	3313.6	3493.6	211	840.8	885.8	3363.2	3543.2
150	828.6	873.6	3314.4	3494.4	212	841.0	886.0	3364.0	3544.0
151	828.8	873.8	3315.2	3495.2	213	841.2	886.2	3364.8	3544.8
152	829.0	874.0	3316.0	3496.0	214	841.4	886.4	3365.6	3545.6
153	829.2	874.2	3316.8	3496.8	215	841.6	886.6	3366.4	3546.4
154	829.4	874.4	3317.6	3497.6	216	841.8	886.8	3367.2	3547.2
155	829.6	874.6	3318.4	3498.4	217	842.0	887.0	3368.0	3548.0
156	829.8	874.8	3319.2	3499.2	218	842.2	887.2	3368.8	3548.8
157	830.0	875.0	3320.0	3500.0	219	842.4	887.4	3369.6	3549.6
158	830.2	875.2	3320.8	3500.8	220	842.6	887.6	3370.4	3550.4
159	830.4	875.4	3321.6	3501.6	221	842.8	887.8	3371.2	3551.2
160	830.6	875.6	3322.4	3502.4	222	843.0	888.0	3372.0	3552.0
161	830.8	875.8	3323.2	3503.2	223	843.2	888.2	3372.8	3552.8
162	831.0	876.0	3324.0	3504.0	224	843.4	888.4	3373.6	3553.6
163	831.2	876.2	3324.8	3504.8	225	843.6	888.6	3374.4	3554.4
164	831.4	876.4	3325.6	3505.6	226	843.8	888.8	3375.2	3555.2
165	831.6	876.6	3326.4	3506.4	227	844.0	889.0	3376.0	3556.0
166	831.8	876.8	3327.2	3507.2	228	844.2	889.2	3376.8	3556.8
167	832.0	877.0	3328.0	3508.0	229	844.4	889.4	3377.6	3557.6
168	832.2	877.2	3328.8	3508.8	230	844.6	889.6	3378.4	3558.4
169	832.4	877.4	3329.6	3509.6	231	844.8	889.8	3379.2	3559.2
170	832.6	877.6	3330.4	3510.4	232	845.0	890.0	3380.0	3560.0
171	832.8	877.8	3331.2	3511.2	233	845.2	890.2	3380.8	3560.8
172	833.0	878.0	3332.0	3512.0	234	845.4	890.4	3381.6	3561.6
173	833.2	878.2	3332.8	3512.8	235	845.6	890.6	3382.4	3562.4
174	833.4	878.4	3333.6	3513.6	236	845.8	890.8	3383.2	3563.2
175	833.6	878.6	3334.4	3514.4	237	846.0	891.0	3384.0	3564.0
176	833.8	878.8	3335.2	3515.2	238	846.2	891.2	3384.8	3564.8
177	834.0	879.0	3336.0	3516.0	239	846.4	891.4	3385.6	3565.6
178	834.2	879.2	3336.8	3516.8	240	846.6	891.6	3386.4	3566.4
179	834.4	879.4	3337.6	3517.6	241	846.8	891.8	3387.2	3567.2
180	834.6	879.6	3338.4	3518.4	242	847.0	892.0	3388.0	3568.0
181	834.8	879.8	3339.2	3519.2	243	847.2	892.2	3388.8	3568.8
182	835.0	880.0	3340.0	3520.0	244	847.4	892.4	3389.6	3569.6
183	835.2	880.2	3340.8	3520.8	245	847.6	892.6	3390.4	3570.4
184	835.4	880.4	3341.6	3521.6	246	847.8	892.8	3391.2	3571.2
185	835.6	880.6	3342.4	3522.4	247	848.0	893.0	3392.0	3572.0
186	835.8	880.8	3343.2	3523.2	248	848.2	893.2	3392.8	3572.8
187	836.0	881.0	3344.0	3524.0	249	848.4	893.4	3393.6	3573.6
188	836.2	881.2	3344.8	3524.8	250	848.6	893.6	3394.4	3574.4
189	836.4	881.4	3345.6	3525.6	251	848.8	893.8	3395.2	3575.2

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GSM900 (including EGSM900)

Frequency list EGSM900														
CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
975	880.2	925.2	3520.8	3700.8	1	890.2	935.2	3560.8	3740.8	63	902.6	947.6	3610.4	3790.4
976	880.4	925.4	3521.6	3701.6	2	890.4	935.4	3561.6	3741.6	64	902.8	947.8	3611.2	3791.2
977	880.6	925.6	3522.4	3702.4	3	890.6	935.6	3562.4	3742.4	65	903.0	948.0	3612.0	3792.0
978	880.8	925.8	3523.2	3703.2	4	890.8	935.8	3563.2	3743.2	66	903.2	948.2	3612.8	3792.8
979	881.0	926.0	3524.0	3704.0	5	891.0	936.0	3564.0	3744.0	67	903.4	948.4	3613.6	3793.6
980	881.2	926.2	3524.8	3704.8	6	891.2	936.2	3564.8	3744.8	68	903.6	948.6	3614.4	3794.4
981	881.4	926.4	3525.6	3705.6	7	891.4	936.4	3565.6	3745.6	69	903.8	948.8	3615.2	3795.2
982	881.6	926.6	3526.4	3706.4	8	891.6	936.6	3566.4	3746.4	70	904.0	949.0	3616.0	3796.0
983	881.8	926.8	3527.2	3707.2	9	891.8	936.8	3567.2	3747.2	71	904.2	949.2	3616.8	3796.8
984	882.0	927.0	3528.0	3708.0	10	892.0	937.0	3568.0	3748.0	72	904.4	949.4	3617.6	3797.6
985	882.2	927.2	3528.8	3708.8	11	892.2	937.2	3568.8	3748.8	73	904.6	949.6	3618.4	3798.4
986	882.4	927.4	3529.6	3709.6	12	892.4	937.4	3569.6	3749.6	74	904.8	949.8	3619.2	3799.2
987	882.6	927.6	3530.4	3710.4	13	892.6	937.6	3570.4	3750.4	75	905.0	950.0	3620.0	3800.0
988	882.8	927.8	3531.2	3711.2	14	892.8	937.8	3571.2	3751.2	76	905.2	950.2	3620.8	3800.8
989	883.0	928.0	3532.0	3712.0	15	893.0	938.0	3572.0	3752.0	77	905.4	950.4	3621.6	3801.6
990	883.2	928.2	3532.8	3712.8	16	893.2	938.2	3572.8	3752.8	78	905.6	950.6	3622.4	3802.4
991	883.4	928.4	3533.6	3713.6	17	893.4	938.4	3573.6	3753.6	79	905.8	950.8	3623.2	3803.2
992	883.6	928.6	3534.4	3714.4	18	893.6	938.6	3574.4	3754.4	80	906.0	951.0	3624.0	3804.0
993	883.8	928.8	3535.2	3715.2	19	893.8	938.8	3575.2	3755.2	81	906.2	951.2	3624.8	3804.8
994	884.0	929.0	3536.0	3716.0	20	894.0	939.0	3576.0	3756.0	82	906.4	951.4	3625.6	3805.6
995	884.2	929.2	3536.8	3716.8	21	894.2	939.2	3576.8	3756.8	83	906.6	951.6	3626.4	3806.4
996	884.4	929.4	3537.6	3717.6	22	894.4	939.4	3577.6	3757.6	84	906.8	951.8	3627.2	3807.2
997	884.6	929.6	3538.4	3718.4	23	894.6	939.6	3578.4	3758.4	85	907.0	952.0	3628.0	3808.0
998	884.8	929.8	3539.2	3719.2	24	894.8	939.8	3579.2	3759.2	86	907.2	952.2	3628.8	3808.8
999	885.0	930.0	3540.0	3720.0	25	895.0	940.0	3580.0	3760.0	87	907.4	952.4	3629.6	3809.6
1000	885.2	930.2	3540.8	3720.8	26	895.2	940.2	3580.8	3760.8	88	907.6	952.6	3630.4	3810.4
1001	885.4	930.4	3541.6	3721.6	27	895.4	940.4	3581.6	3761.6	89	907.8	952.8	3631.2	3811.2
1002	885.6	930.6	3542.4	3722.4	28	895.6	940.6	3582.4	3762.4	90	908.0	953.0	3632.0	3812.0
1003	885.8	930.8	3543.2	3723.2	29	895.8	940.8	3583.2	3763.2	91	908.2	953.2	3632.8	3812.8
1004	886.0	931.0	3544.0	3724.0	30	896.0	941.0	3584.0	3764.0	92	908.4	953.4	3633.6	3813.6
1005	886.2	931.2	3544.8	3724.8	31	896.2	941.2	3584.8	3764.8	93	908.6	953.6	3634.4	3814.4
1006	886.4	931.4	3545.6	3725.6	32	896.4	941.4	3585.6	3765.6	94	908.8	953.8	3635.2	3815.2
1007	886.6	931.6	3546.4	3726.4	33	896.6	941.6	3586.4	3766.4	95	909.0	954.0	3636.0	3816.0
1008	886.8	931.8	3547.2	3727.2	34	896.8	941.8	3587.2	3767.2	96	909.2	954.2	3636.8	3816.8
1009	887.0	932.0	3548.0	3728.0	35	897.0	942.0	3588.0	3768.0	97	909.4	954.4	3637.6	3817.6
1010	887.2	932.2	3548.8	3728.8	36	897.2	942.2	3588.8	3768.8	98	909.6	954.6	3638.4	3818.4
1011	887.4	932.4	3549.6	3729.6	37	897.4	942.4	3589.6	3769.6	99	909.8	954.8	3639.2	3819.2
1012	887.6	932.6	3550.4	3730.4	38	897.6	942.6	3590.4	3770.4	100	910.0	955.0	3640.0	3820.0
1013	887.8	932.8	3551.2	3731.2	39	897.8	942.8	3591.2	3771.2	101	910.2	955.2	3640.8	3820.8
1014	888.0	933.0	3552.0	3732.0	40	898.0	943.0	3592.0	3772.0	102	910.4	955.4	3641.6	3821.6
1015	888.2	933.2	3552.8	3732.8	41	898.2	943.2	3592.8	3772.8	103	910.6	955.6	3642.4	3822.4
1016	888.4	933.4	3553.6	3733.6	42	898.4	943.4	3593.6	3773.6	104	910.8	955.8	3643.2	3823.2
1017	888.6	933.6	3554.4	3734.4	43	898.6	943.6	3594.4	3774.4	105	911.0	956.0	3644.0	3824.0
1018	888.8	933.8	3555.2	3735.2	44	898.8	943.8	3595.2	3775.2	106	911.2	956.2	3644.8	3824.8
1019	889.0	934.0	3556.0	3736.0	45	899.0	944.0	3596.0	3776.0	107	911.4	956.4	3645.6	3825.6
1020	889.2	934.2	3556.8	3736.8	46	899.2	944.2	3596.8	3776.8	108	911.6	956.6	3646.4	3826.4
1021	889.4	934.4	3557.6	3737.6	47	899.4	944.4	3597.6	3777.6	109	911.8	956.8	3647.2	3827.2
1022	889.6	934.6	3558.4	3738.4	48	899.6	944.6	3598.4	3778.4	110	912.0	957.0	3648.0	3828.0
1023	889.8	934.8	3559.2	3739.2	49	899.8	944.8	3599.2	3779.2	111	912.2	957.2	3648.8	3828.8
0	890.0	935.0	3560.0	3740.0	50	900.0	945.0	3600.0	3780.0	112	912.4	957.4	3649.6	3829.6
					51	900.2	945.2	3600.8	3780.8	113	912.6	957.6	3650.4	3830.4
					52	900.4	945.4	3601.6	3781.6	114	912.8	957.8	3651.2	3831.2
					53	900.6	945.6	3602.4	3782.4	115	913.0	958.0	3652.0	3832.0
					54	900.8	945.8	3603.2	3783.2	116	913.2	958.2	3652.8	3832.8
					55	901.0	946.0	3604.0	3784.0	117	913.4	958.4	3653.6	3833.6
					56	901.2	946.2	3604.8	3784.8	118	913.6	958.6	3654.4	3834.4
					57	901.4	946.4	3605.6	3785.6	119	913.8	958.8	3655.2	3835.2
					58	901.6	946.6	3606.4	3786.4	120	914.0	959.0	3656.0	3836.0
					59	901.8	946.8	3607.2	3787.2	121	914.2	959.2	3656.8	3836.8
					60	902.0	947.0	3608.0	3788.0	122	914.4	959.4	3657.6	3837.6
					61	902.2	947.2	3608.8	3788.8	123	914.6	959.6	3658.4	3838.4
					62	902.4	947.4	3609.6	3789.6	124	914.8	959.8	3659.2	3839.2

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GSM1800

Frequency list GSM1800																			
CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	794	1766.6	1861.6	3533.2	3723.2
513	1710.4	1805.4	3420.8	3610.8	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	795	1766.8	1861.8	3533.6	3723.6
514	1710.6	1805.6	3421.2	3611.2	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	796	1767.0	1862.0	3534.0	3724.0
515	1710.8	1805.8	3421.6	3611.6	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	797	1767.2	1862.2	3534.4	3724.4
516	1711.0	1806.0	3422.0	3612.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	798	1767.4	1862.4	3534.8	3724.8
517	1711.2	1806.2	3422.4	3612.4	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	799	1767.6	1862.6	3535.2	3725.2
518	1711.4	1806.4	3422.8	3612.8	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	800	1767.8	1862.8	3535.6	3725.6
519	1711.6	1806.6	3423.2	3613.2	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	801	1768.0	1863.0	3536.0	3726.0
520	1711.8	1806.8	3423.6	3613.6	614	1730.6	1825.6	3461.2	3651.2	708	1749.4	1844.4	3498.8	3688.8	802	1768.2	1863.2	3536.4	3726.4
521	1712.0	1807.0	3424.0	3614.0	615	1730.8	1825.8	3461.6	3651.6	709	1749.6	1844.6	3499.2	3689.2	803	1768.4	1863.4	3536.8	3726.8
522	1712.2	1807.2	3424.4	3614.4	616	1731.0	1826.0	3462.0	3652.0	710	1749.8	1844.8	3499.6	3689.6	804	1768.6	1863.6	3537.2	3727.2
523	1712.4	1807.4	3424.8	3614.8	617	1731.2	1826.2	3462.4	3652.4	711	1750.0	1845.0	3500.0	3690.0	805	1768.8	1863.8	3537.6	3727.6
524	1712.6	1807.6	3425.2	3615.2	618	1731.4	1826.4	3462.8	3652.8	712	1750.2	1845.2	3500.4	3690.4	806	1769.0	1864.0	3538.0	3728.0
525	1712.8	1807.8	3425.6	3615.6	619	1731.6	1826.6	3463.2	3653.2	713	1750.4	1845.4	3500.8	3690.8	807	1769.2	1864.2	3538.4	3728.4
526	1713.0	1808.0	3426.0	3616.0	620	1731.8	1826.8	3463.6	3653.6	714	1750.6	1845.6	3501.2	3691.2	808	1769.4	1864.4	3538.8	3728.8
527	1713.2	1808.2	3426.4	3616.4	621	1732.0	1827.0	3464.0	3654.0	715	1750.8	1845.8	3501.6	3691.6	809	1769.6	1864.6	3539.2	3729.2
528	1713.4	1808.4	3426.8	3616.8	622	1732.2	1827.2	3464.4	3654.4	716	1751.0	1846.0	3502.0	3692.0	810	1769.8	1864.8	3539.6	3729.6
529	1713.6	1808.6	3427.2	3617.2	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	811	1770.0	1865.0	3540.0	3730.0
530	1713.8	1808.8	3427.6	3617.6	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	812	1770.2	1865.2	3540.4	3730.4
531	1714.0	1809.0	3428.0	3618.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	813	1770.4	1865.4	3540.8	3730.8
532	1714.2	1809.2	3428.4	3618.4	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	814	1770.6	1865.6	3541.2	3731.2
533	1714.4	1809.4	3428.8	3618.8	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	815	1770.8	1865.8	3541.6	3731.6
534	1714.6	1809.6	3429.2	3619.2	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	816	1771.0	1866.0	3542.0	3732.0
535	1714.8	1809.8	3429.6	3619.6	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	817	1771.2	1866.2	3542.4	3732.4
536	1715.0	1810.0	3430.0	3620.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	818	1771.4	1866.4	3542.8	3732.8
537	1715.2	1810.2	3430.4	3620.4	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	819	1771.6	1866.6	3543.2	3733.2
538	1715.4	1810.4	3430.8	3620.8	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	820	1771.8	1866.8	3543.6	3733.6
539	1715.6	1810.6	3431.2	3621.2	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	821	1772.0	1867.0	3544.0	3734.0
540	1715.8	1810.8	3431.6	3621.6	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	822	1772.2	1867.2	3544.4	3734.4
541	1716.0	1811.0	3432.0	3622.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	823	1772.4	1867.4	3544.8	3734.8
542	1716.2	1811.2	3432.4	3622.4	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	824	1772.6	1867.6	3545.2	3735.2
543	1716.4	1811.4	3432.8	3622.8	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	825	1772.8	1867.8	3545.6	3735.6
544	1716.6	1811.6	3433.2	3623.2	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	826	1773.0	1868.0	3546.0	3736.0
545	1716.8	1811.8	3433.6	3623.6	639	1735.6	1830.6	3471.2	3661.2	733	1754.4	1849.4	3508.8	3698.8	827	1773.2	1868.2	3546.4	3736.4
546	1717.0	1812.0	3434.0	3624.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	828	1773.4	1868.4	3546.8	3736.8
547	1717.2	1812.2	3434.4	3624.4	641	1736.0	1831.0	3472.0	3662.0	735	1754.8	1849.8	3509.6	3699.6	829	1773.6	1868.6	3547.2	3737.2
548	1717.4	1812.4	3434.8	3624.8	642	1736.2	1831.2	3472.4	3662.4	736	1755.0	1850.0	3510.0	3700.0	830	1773.8	1868.8	3547.6	3737.6
549	1717.6	1812.6	3435.2	3625.2	643	1736.4	1831.4	3472.8	3662.8	737	1755.2	1850.2	3510.4	3700.4	831	1774.0	1869.0	3548.0	3738.0
550	1717.8	1812.8	3435.6	3625.6	644	1736.6	1831.6	3473.2	3663.2	738	1755.4	1850.4	3510.8	3700.8	832	1774.2	1869.2	3548.4	3738.4
551	1718.0	1813.0	3436.0	3626.0	645	1736.8	1831.8	3473.6	3663.6	739	1755.6	1850.6	3511.2	3701.2	833	1774.4	1869.4	3548.8	3738.8
552	1718.2	1813.2	3436.4	3626.4	646	1737.0	1832.0	3474.0	3664.0	740	1755.8	1850.8	3511.6	3701.6	834	1774.6	1869.6	3549.2	3739.2
553	1718.4	1813.4	3436.8	3626.8	647	1737.2	1832.2	3474.4	3664.4	741	1756.0	1851.0	3512.0	3702.0	835	1774.8	1869.8	3549.6	3739.6
554	1718.6	1813.6	3437.2	3627.2	648	1737.4	1832.4	3474.8	3664.8	742	1756.2	1851.2	3512.4	3702.4	836	1775.0	1870.0	3550.0	3740.0
555	1718.8	1813.8	3437.6	3627.6	649	1737.6	1832.6	3475.2	3665.2	743	1756.4	1851.4	3512.8	3702.8	837	1775.2	1870.2	3550.4	3740.4
556	1719.0	1814.0	3438.0	3628.0	650	1737.8	1832.8	3475.6	3665.6	744	1756.6	1851.6	3513.2	3703.2	838	1775.4	1870.4	3550.8	3740.8
557	1719.2	1814.2	3438.4	3628.4	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	839	1775.6	1870.6	3551.2	3741.2
558	1719.4	1814.4	3438.8	3628.8	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	840	1775.8	1870.8	3551.6	3741.6
559	1719.6	1814.6	3439.2	3629.2	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	841	1776.0	1871.0	3552.0	3742.0
560	1719.8	1814.8	3439.6	3629.6	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	842	1776.2	1871.2	3552.4	3742.4
561	1720.0	1815.0	3440.0	3630.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	843	1776.4	1871.4	3552.8	3742.8
562	1720.2	1815.2	3440.4	3630.4	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	844	1776.6	1871.6	3553.2	3743.2
563	1720.4	1815.4	3440.8	3630.8	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	845	1776.8	1871.8	3553.6	3743.6
564	1720.6	1815.6	3441.2	3631.2	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	846	1777.0	1872.0	3554.0	3744.0
565	1720.8	1815.8	3441.6	3631.6	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	847	1777.2	1872.2	3554.4	3744.4
566	1721.0	1816.0	3442.0	3632.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	848	1777.4	1872.4	3554.8	3744.8
567	1721.2	1816.2	3442.4	3632.4	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	849	1777.6	1872.6	3555.2	3745.2
568	1721.4	1816.4	3442.8	3632.8	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	850	1777.8	1872.8	3555.6	3745.6
569	1721.6	1816.6	3443.2	3633.2	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	851	1778.0	1873.0	3556.0	3746.0
570	1721.8	1816.8	3443.6	3633.6	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4

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570	1721.8	1816.8	3443.6	3633.6	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4
571	1722.0	1817.0	3444.0	3634.0	665	1740.8	1835.8	3481.6	3671.6	759	1759.6	1854.6	3519.2	3709.2	853	1778.4	1873.4	3556.8	3746.8
572	1722.2	1817.2	3444.4	3634.4	666	1741.0	1836.0	3482.0	3672.0	760	1759.8	1854.8	3519.6	3709.6	854	1778.6	1873.6	3557.2	3747.2
573	1722.4	1817.4	3444.8	3634.8	667	1741.2	1836.2	3482.4	3672.4	761	1760.0	1855.0	3520.0	3710.0	855	1778.8	1873.8	3557.6	3747.6
574	1722.6	1817.6	3445.2	3635.2	668	1741.4	1836.4	3482.8	3672.8	762	1760.2	1855.2	3520.4	3710.4	856	1779.0	1874.0	3558.0	3748.0
575	1722.8	1817.8	3445.6	3635.6	669	1741.6	1836.6	3483.2	3673.2	763	1760.4	1855.4	3520.8	3710.8	857	1779.2	1874.2	3558.4	3748.4
576	1723.0	1818.0	3446.0	3636.0	670	1741.8	1836.8	3483.6	3673.6	764	1760.6	1855.6	3521.2	3711.2	858	1779.4	1874.4	3558.8	3748.8
577	1723.2	1818.2	3446.4	3636.4	671	1742.0	1837.0	3484.0	3674.0	765	1760.8	1855.8	3521.6	3711.6	859	1779.6	1874.6	3559.2	3749.2
578	1723.4	1818.4	3446.8	3636.8	672	1742.2	1837.2	3484.4	3674.4	766	1761.0	1856.0	3522.0	3712.0	860	1779.8	1874.8	3559.6	3749.6
579	1723.6	1818.6	3447.2	3637.2	673	1742.4	1837.4	3484.8	3674.8	767	1761.2	1856.2	3522.4	3712.4	861	1780.0	1875.0	3560.0	3750.0
580	1723.8	1818.8	3447.6	3637.6	674	1742.6	1837.6	3485.2	3675.2	768	1761.4	1856.4	3522.8	3712.8	862	1780.2	1875.2	3560.4	3750.4
581	1724.0	1819.0	3448.0	3638.0	675	1742.8	1837.8	3485.6	3675.6	769	1761.6	1856.6	3523.2	3713.2	863	1780.4	1875.4	3560.8	3750.8
582	1724.2	1819.2	3448.4	3638.4	676	1743.0	1838.0	3486.0	3676.0	770	1761.8	1856.8	3523.6	3713.6	864	1780.6	1875.6	3561.2	3751.2
583	1724.4	1819.4	3448.8	3638.8	677	1743.2	1838.2	3486.4	3676.4	771	1762.0	1857.0	3524.0	3714.0	865	1780.8	1875.8	3561.6	3751.6
584	1724.6	1819.6	3449.2	3639.2	678	1743.4	1838.4	3486.8	3676.8	772	1762.2	1857.2	3524.4	3714.4	866	1781.0	1876.0	3562.0	3752.0
585	1724.8	1819.8	3449.6	3639.6	679	1743.6	1838.6	3487.2	3677.2	773	1762.4	1857.4	3524.8	3714.8	867	1781.2	1876.2	3562.4	3752.4
586	1725.0	1820.0	3450.0	3640.0	680	1743.8	1838.8	3487.6	3677.6	774	1762.6	1857.6	3525.2	3715.2	868	1781.4	1876.4	3562.8	3752.8
587	1725.2	1820.2	3450.4	3640.4	681	1744.0	1839.0	3488.0	3678.0	775	1762.8	1857.8	3525.6	3715.6	869	1781.6	1876.6	3563.2	3753.2
588	1725.4	1820.4	3450.8	3640.8	682	1744.2	1839.2	3488.4	3678.4	776	1763.0	1858.0	3526.0	3716.0	870	1781.8	1876.8	3563.6	3753.6
589	1725.6	1820.6	3451.2	3641.2	683	1744.4	1839.4	3488.8	3678.8	777	1763.2	1858.2	3526.4	3716.4	871	1782.0	1877.0	3564.0	3754.0
590	1725.8	1820.8	3451.6	3641.6	684	1744.6	1839.6	3489.2	3679.2	778	1763.4	1858.4	3526.8	3716.8	872	1782.2	1877.2	3564.4	3754.4
591	1726.0	1821.0	3452.0	3642.0	685	1744.8	1839.8	3489.6	3679.6	779	1763.6	1858.6	3527.2	3717.2	873	1782.4	1877.4	3564.8	3754.8
592	1726.2	1821.2	3452.4	3642.4	686	1745.0	1840.0	3490.0	3680.0	780	1763.8	1858.8	3527.6	3717.6	874	1782.6	1877.6	3565.2	3755.2
593	1726.4	1821.4	3452.8	3642.8	687	1745.2	1840.2	3490.4	3680.4	781	1764.0	1859.0	3528.0	3718.0	875	1782.8	1877.8	3565.6	3755.6
594	1726.6	1821.6	3453.2	3643.2	688	1745.4	1840.4	3490.8	3680.8	782	1764.2	1859.2	3528.4	3718.4	876	1783.0	1878.0	3566.0	3756.0
595	1726.8	1821.8	3453.6	3643.6	689	1745.6	1840.6	3491.2	3681.2	783	1764.4	1859.4	3528.8	3718.8	877	1783.2	1878.2	3566.4	3756.4
596	1727.0	1822.0	3454.0	3644.0	690	1745.8	1840.8	3491.6	3681.6	784	1764.6	1859.6	3529.2	3719.2	878	1783.4	1878.4	3566.8	3756.8
597	1727.2	1822.2	3454.4	3644.4	691	1746.0	1841.0	3492.0	3682.0	785	1764.8	1859.8	3529.6	3719.6	879	1783.6	1878.6	3567.2	3757.2
598	1727.4	1822.4	3454.8	3644.8	692	1746.2	1841.2	3492.4	3682.4	786	1765.0	1860.0	3530.0	3720.0	880	1783.8	1878.8	3567.6	3757.6
599	1727.6	1822.6	3455.2	3645.2	693	1746.4	1841.4	3492.8	3682.8	787	1765.2	1860.2	3530.4	3720.4	881	1784.0	1879.0	3568.0	3758.0
600	1727.8	1822.8	3455.6	3645.6	694	1746.6	1841.6	3493.2	3683.2	788	1765.4	1860.4	3530.8	3720.8	882	1784.2	1879.2	3568.4	3758.4
601	1728.0	1823.0	3456.0	3646.0	695	1746.8	1841.8	3493.6	3683.6	789	1765.6	1860.6	3531.2	3721.2	883	1784.4	1879.4	3568.8	3758.8
602	1728.2	1823.2	3456.4	3646.4	696	1747.0	1842.0	3494.0	3684.0	790	1765.8	1860.8	3531.6	3721.6	884	1784.6	1879.6	3569.2	3759.2
603	1728.4	1823.4	3456.8	3646.8	697	1747.2	1842.2	3494.4	3684.4	791	1766.0	1861.0	3532.0	3722.0	885	1784.8	1879.8	3569.6	3759.6
604	1728.6	1823.6	3457.2	3647.2	698	1747.4	1842.4	3494.8	3684.8	792	1766.2	1861.2	3532.4	3722.4					
605	1728.8	1823.8	3457.6	3647.6	699	1747.6	1842.6	3495.2	3685.2	793	1766.4	1861.4	3532.8	3722.8					

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GSM1900

Frequency list NPL-2 GSM1900																			
CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1850.2	1930.2	3700.4	3860.4	606	1869.0	1949.0	3738.0	3898.0	700	1887.8	1967.8	3775.6	3935.6	794	1906.6	1986.6	3813.2	3973.2
513	1850.4	1930.4	3700.8	3860.8	607	1869.2	1949.2	3738.4	3898.4	701	1888.0	1968.0	3776.0	3936.0	795	1906.8	1986.8	3813.6	3973.6
514	1850.6	1930.6	3701.2	3861.2	608	1869.4	1949.4	3738.8	3898.8	702	1888.2	1968.2	3776.4	3936.4	796	1907.0	1987.0	3814.0	3974.0
515	1850.8	1930.8	3701.6	3861.6	609	1869.6	1949.6	3739.2	3899.2	703	1888.4	1968.4	3776.8	3936.8	797	1907.2	1987.2	3814.4	3974.4
516	1851.0	1931.0	3702.0	3862.0	610	1869.8	1949.8	3739.6	3899.6	704	1888.6	1968.6	3777.2	3937.2	798	1907.4	1987.4	3814.8	3974.8
517	1851.2	1931.2	3702.4	3862.4	611	1870.0	1950.0	3740.0	3900.0	705	1888.8	1968.8	3777.6	3937.6	799	1907.6	1987.6	3815.2	3975.2
518	1851.4	1931.4	3702.8	3862.8	612	1870.2	1950.2	3740.4	3900.4	706	1889.0	1969.0	3778.0	3938.0	800	1907.8	1987.8	3815.6	3975.6
519	1851.6	1931.6	3703.2	3863.2	613	1870.4	1950.4	3740.8	3900.8	707	1889.2	1969.2	3778.4	3938.4	801	1908.0	1988.0	3816.0	3976.0
520	1851.8	1931.8	3703.6	3863.6	614	1870.6	1950.6	3741.2	3901.2	708	1889.4	1969.4	3778.8	3938.8	802	1908.2	1988.2	3816.4	3976.4
521	1852.0	1932.0	3704.0	3864.0	615	1870.8	1950.8	3741.6	3901.6	709	1889.6	1969.6	3779.2	3939.2	803	1908.4	1988.4	3816.8	3976.8
522	1852.2	1932.2	3704.4	3864.4	616	1871.0	1951.0	3742.0	3902.0	710	1889.8	1969.8	3779.6	3939.6	804	1908.6	1988.6	3817.2	3977.2
523	1852.4	1932.4	3704.8	3864.8	617	1871.2	1951.2	3742.4	3902.4	711	1890.0	1970.0	3780.0	3940.0	805	1908.8	1988.8	3817.6	3977.6
524	1852.6	1932.6	3705.2	3865.2	618	1871.4	1951.4	3742.8	3902.8	712	1890.2	1970.2	3780.4	3940.4	806	1909.0	1989.0	3818.0	3978.0
525	1852.8	1932.8	3705.6	3865.6	619	1871.6	1951.6	3743.2	3903.2	713	1890.4	1970.4	3780.8	3940.8	807	1909.2	1989.2	3818.4	3978.4
526	1853.0	1933.0	3706.0	3866.0	620	1871.8	1951.8	3743.6	3903.6	714	1890.6	1970.6	3781.2	3941.2	808	1909.4	1989.4	3818.8	3978.8
527	1853.2	1933.2	3706.4	3866.4	621	1872.0	1952.0	3744.0	3904.0	715	1890.8	1970.8	3781.6	3941.6	809	1909.6	1989.6	3819.2	3979.2
528	1853.4	1933.4	3706.8	3866.8	622	1872.2	1952.2	3744.4	3904.4	716	1891.0	1971.0	3782.0	3942.0	810	1909.8	1989.8	3819.6	3979.6
529	1853.6	1933.6	3707.2	3867.2	623	1872.4	1952.4	3744.8	3904.8	717	1891.2	1971.2	3782.4	3942.4					
530	1853.8	1933.8	3707.6	3867.6	624	1872.6	1952.6	3745.2	3905.2	718	1891.4	1971.4	3782.8	3942.8					
531	1854.0	1934.0	3708.0	3868.0	625	1872.8	1952.8	3745.6	3905.6	719	1891.6	1971.6	3783.2	3943.2					
532	1854.2	1934.2	3708.4	3868.4	626	1873.0	1953.0	3746.0	3906.0	720	1891.8	1971.8	3783.6	3943.6					
533	1854.4	1934.4	3708.8	3868.8	627	1873.2	1953.2	3746.4	3906.4	721	1892.0	1972.0	3784.0	3944.0					
534	1854.6	1934.6	3709.2	3869.2	628	1873.4	1953.4	3746.8	3906.8	722	1892.2	1972.2	3784.4	3944.4					
535	1854.8	1934.8	3709.6	3869.6	629	1873.6	1953.6	3747.2	3907.2	723	1892.4	1972.4	3784.8	3944.8					
536	1855.0	1935.0	3710.0	3870.0	630	1873.8	1953.8	3747.6	3907.6	724	1892.6	1972.6	3785.2	3945.2					
537	1855.2	1935.2	3710.4	3870.4	631	1874.0	1954.0	3748.0	3908.0	725	1892.8	1972.8	3785.6	3945.6					
538	1855.4	1935.4	3710.8	3870.8	632	1874.2	1954.2	3748.4	3908.4	726	1893.0	1973.0	3786.0	3946.0					
539	1855.6	1935.6	3711.2	3871.2	633	1874.4	1954.4	3748.8	3908.8	727	1893.2	1973.2	3786.4	3946.4					
540	1855.8	1935.8	3711.6	3871.6	634	1874.6	1954.6	3749.2	3909.2	728	1893.4	1973.4	3786.8	3946.8					
541	1856.0	1936.0	3712.0	3872.0	635	1874.8	1954.8	3749.6	3909.6	729	1893.6	1973.6	3787.2	3947.2					
542	1856.2	1936.2	3712.4	3872.4	636	1875.0	1955.0	3750.0	3910.0	730	1893.8	1973.8	3787.6	3947.6					
543	1856.4	1936.4	3712.8	3872.8	637	1875.2	1955.2	3750.4	3910.4	731	1894.0	1974.0	3788.0	3948.0					
544	1856.6	1936.6	3713.2	3873.2	638	1875.4	1955.4	3750.8	3910.8	732	1894.2	1974.2	3788.4	3948.4					
545	1856.8	1936.8	3713.6	3873.6	639	1875.6	1955.6	3751.2	3911.2	733	1894.4	1974.4	3788.8	3948.8					
546	1857.0	1937.0	3714.0	3874.0	640	1875.8	1955.8	3751.6	3911.6	734	1894.6	1974.6	3789.2	3949.2					
547	1857.2	1937.2	3714.4	3874.4	641	1876.0	1956.0	3752.0	3912.0	735	1894.8	1974.8	3789.6	3949.6					
548	1857.4	1937.4	3714.8	3874.8	642	1876.2	1956.2	3752.4	3912.4	736	1895.0	1975.0	3790.0	3950.0					
549	1857.6	1937.6	3715.2	3875.2	643	1876.4	1956.4	3752.8	3912.8	737	1895.2	1975.2	3790.4	3950.4					
550	1857.8	1937.8	3715.6	3875.6	644	1876.6	1956.6	3753.2	3913.2	738	1895.4	1975.4	3790.8	3950.8					
551	1858.0	1938.0	3716.0	3876.0	645	1876.8	1956.8	3753.6	3913.6	739	1895.6	1975.6	3791.2	3951.2					
552	1858.2	1938.2	3716.4	3876.4	646	1877.0	1957.0	3754.0	3914.0	740	1895.8	1975.8	3791.6	3951.6					
553	1858.4	1938.4	3716.8	3876.8	647	1877.2	1957.2	3754.4	3914.4	741	1896.0	1976.0	3792.0	3952.0					
554	1858.6	1938.6	3717.2	3877.2	648	1877.4	1957.4	3754.8	3914.8	742	1896.2	1976.2	3792.4	3952.4					
555	1858.8	1938.8	3717.6	3877.6	649	1877.6	1957.6	3755.2	3915.2	743	1896.4	1976.4	3792.8	3952.8					
556	1859.0	1939.0	3718.0	3878.0	650	1877.8	1957.8	3755.6	3915.6	744	1896.6	1976.6	3793.2	3953.2					
557	1859.2	1939.2	3718.4	3878.4	651	1878.0	1958.0	3756.0	3916.0	745	1896.8	1976.8	3793.6	3953.6					
558	1859.4	1939.4	3718.8	3878.8	652	1878.2	1958.2	3756.4	3916.4	746	1897.0	1977.0	3794.0	3954.0					
559	1859.6	1939.6	3719.2	3879.2	653	1878.4	1958.4	3756.8	3916.8	747	1897.2	1977.2	3794.4	3954.4					
560	1859.8	1939.8	3719.6	3879.6	654	1878.6	1958.6	3757.2	3917.2	748	1897.4	1977.4	3794.8	3954.8					
561	1860.0	1940.0	3720.0	3880.0	655	1878.8	1958.8	3757.6	3917.6	749	1897.6	1977.6	3795.2	3955.2					
562	1860.2	1940.2	3720.4	3880.4	656	1879.0	1959.0	3758.0	3918.0	750	1897.8	1977.8	3795.6	3955.6					
563	1860.4	1940.4	3720.8	3880.8	657	1879.2	1959.2	3758.4	3918.4	751	1898.0	1978.0	3796.0	3956.0					
564	1860.6	1940.6	3721.2	3881.2	658	1879.4	1959.4	3758.8	3918.8	752	1898.2	1978.2	3796.4	3956.4					
565	1860.8	1940.8	3721.6	3881.6	659	1879.6	1959.6	3759.2	3919.2	753	1898.4	1978.4	3796.8	3956.8					
566	1861.0	1941.0	3722.0	3882.0	660	1879.8	1959.8	3759.6	3919.6	754	1898.6	1978.6	3797.2	3957.2					
567	1861.2	1941.2	3722.4	3882.4	661	1880.0	1960.0	3760.0	3920.0	755	1898.8	1978.8	3797.6	3957.6					
568	1861.4	1941.4	3722.8	3882.8	662	1880.2	1960.2	3760.4	3920.4	756	1899.0	1979.0	3798.0	3958.0					
569	1861.6	1941.6	3723.2	3883.2	663	1880.4	1960.4	3760.8	3920.8	757	1899.2	1979.2	3798.4	3958.4					
570	1861.8	1941.8	3723.6	3883.6	664	1880.6	1960.6	3761.2	3921.2	758	1899.4	1979.4	3798.8	3958.8					

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571	1862.0	1942.0	3724.0	3884.0	665	1880.8	1960.8	3761.6	3921.6	759	1899.6	1979.6	3799.2	3959.2					
572	1862.2	1942.2	3724.4	3884.4	666	1881.0	1961.0	3762.0	3922.0	760	1899.8	1979.8	3799.6	3959.6					
573	1862.4	1942.4	3724.8	3884.8	667	1881.2	1961.2	3762.4	3922.4	761	1900.0	1980.0	3800.0	3960.0					
574	1862.6	1942.6	3725.2	3885.2	668	1881.4	1961.4	3762.8	3922.8	762	1900.2	1980.2	3800.4	3960.4					
575	1862.8	1942.8	3725.6	3885.6	669	1881.6	1961.6	3763.2	3923.2	763	1900.4	1980.4	3800.8	3960.8					
576	1863.0	1943.0	3726.0	3886.0	670	1881.8	1961.8	3763.6	3923.6	764	1900.6	1980.6	3801.2	3961.2					
577	1863.2	1943.2	3726.4	3886.4	671	1882.0	1962.0	3764.0	3924.0	765	1900.8	1980.8	3801.6	3961.6					
578	1863.4	1943.4	3726.8	3886.8	672	1882.2	1962.2	3764.4	3924.4	766	1901.0	1981.0	3802.0	3962.0					
579	1863.6	1943.6	3727.2	3887.2	673	1882.4	1962.4	3764.8	3924.8	767	1901.2	1981.2	3802.4	3962.4					
580	1863.8	1943.8	3727.6	3887.6	674	1882.6	1962.6	3765.2	3925.2	768	1901.4	1981.4	3802.8	3962.8					
581	1864.0	1944.0	3728.0	3888.0	675	1882.8	1962.8	3765.6	3925.6	769	1901.6	1981.6	3803.2	3963.2					
582	1864.2	1944.2	3728.4	3888.4	676	1883.0	1963.0	3766.0	3926.0	770	1901.8	1981.8	3803.6	3963.6					
583	1864.4	1944.4	3728.8	3888.8	677	1883.2	1963.2	3766.4	3926.4	771	1902.0	1982.0	3804.0	3964.0					
584	1864.6	1944.6	3729.2	3889.2	678	1883.4	1963.4	3766.8	3926.8	772	1902.2	1982.2	3804.4	3964.4					
585	1864.8	1944.8	3729.6	3889.6	679	1883.6	1963.6	3767.2	3927.2	773	1902.4	1982.4	3804.8	3964.8					
586	1865.0	1945.0	3730.0	3890.0	680	1883.8	1963.8	3767.6	3927.6	774	1902.6	1982.6	3805.2	3965.2					
587	1865.2	1945.2	3730.4	3890.4	681	1884.0	1964.0	3768.0	3928.0	775	1902.8	1982.8	3805.6	3965.6					
588	1865.4	1945.4	3730.8	3890.8	682	1884.2	1964.2	3768.4	3928.4	776	1903.0	1983.0	3806.0	3966.0					
589	1865.6	1945.6	3731.2	3891.2	683	1884.4	1964.4	3768.8	3928.8	777	1903.2	1983.2	3806.4	3966.4					
590	1865.8	1945.8	3731.6	3891.6	684	1884.6	1964.6	3769.2	3929.2	778	1903.4	1983.4	3806.8	3966.8					
591	1866.0	1946.0	3732.0	3892.0	685	1884.8	1964.8	3769.6	3929.6	779	1903.6	1983.6	3807.2	3967.2					
592	1866.2	1946.2	3732.4	3892.4	686	1885.0	1965.0	3770.0	3930.0	780	1903.8	1983.8	3807.6	3967.6					
593	1866.4	1946.4	3732.8	3892.8	687	1885.2	1965.2	3770.4	3930.4	781	1904.0	1984.0	3808.0	3968.0					
594	1866.6	1946.6	3733.2	3893.2	688	1885.4	1965.4	3770.8	3930.8	782	1904.2	1984.2	3808.4	3968.4					
595	1866.8	1946.8	3733.6	3893.6	689	1885.6	1965.6	3771.2	3931.2	783	1904.4	1984.4	3808.8	3968.8					
596	1867.0	1947.0	3734.0	3894.0	690	1885.8	1965.8	3771.6	3931.6	784	1904.6	1984.6	3809.2	3969.2					
597	1867.2	1947.2	3734.4	3894.4	691	1886.0	1966.0	3772.0	3932.0	785	1904.8	1984.8	3809.6	3969.6					
598	1867.4	1947.4	3734.8	3894.8	692	1886.2	1966.2	3772.4	3932.4	786	1905.0	1985.0	3810.0	3970.0					
599	1867.6	1947.6	3735.2	3895.2	693	1886.4	1966.4	3772.8	3932.8	787	1905.2	1985.2	3810.4	3970.4					
600	1867.8	1947.8	3735.6	3895.6	694	1886.6	1966.6	3773.2	3933.2	788	1905.4	1985.4	3810.8	3970.8					
601	1868.0	1948.0	3736.0	3896.0	695	1886.8	1966.8	3773.6	3933.6	789	1905.6	1985.6	3811.2	3971.2					
602	1868.2	1948.2	3736.4	3896.4	696	1887.0	1967.0	3774.0	3934.0	790	1905.8	1985.8	3811.6	3971.6					
603	1868.4	1948.4	3736.8	3896.8	697	1887.2	1967.2	3774.4	3934.4	791	1906.0	1986.0	3812.0	3972.0					
604	1868.6	1948.6	3737.2	3897.2	698	1887.4	1967.4	3774.8	3934.8	792	1906.2	1986.2	3812.4	3972.4					
605	1868.8	1948.8	3737.6	3897.6	699	1887.6	1967.6	3775.2	3935.2	793	1906.4	1986.4	3812.8	3972.8					

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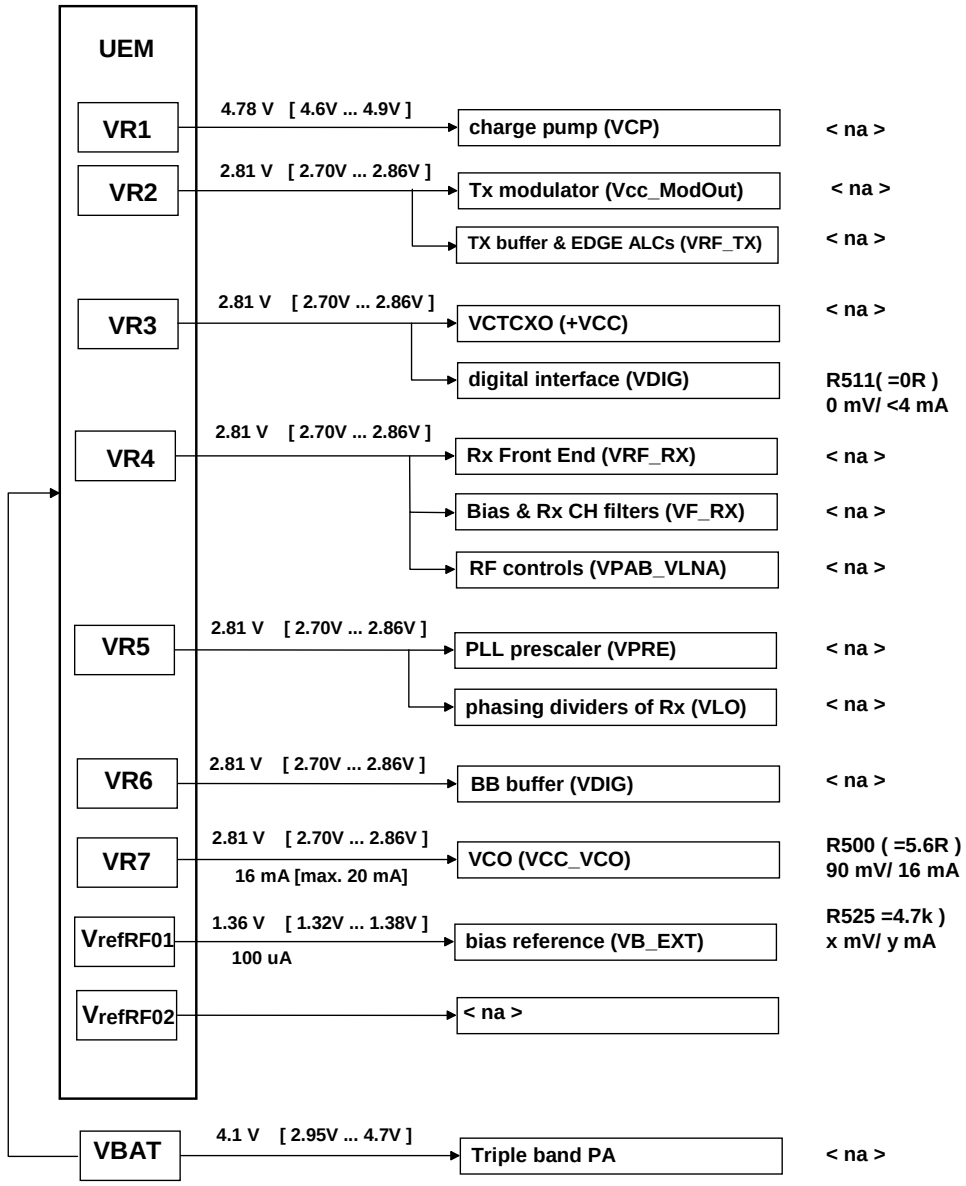
DC Supply Current Check

For a quick check of DC power supplies refer to the diagram below. Voltage drops are measured at the respective resistors pads. Note, that not all currents can be checked in such a way, see the marking <na> (not applicable) in the diagram.

Figure 32: DC Power Supply Diagram



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Baseband Troubleshooting

BB measurement points

Figure 33: NPL-4/5 BB Measurement Points, Top

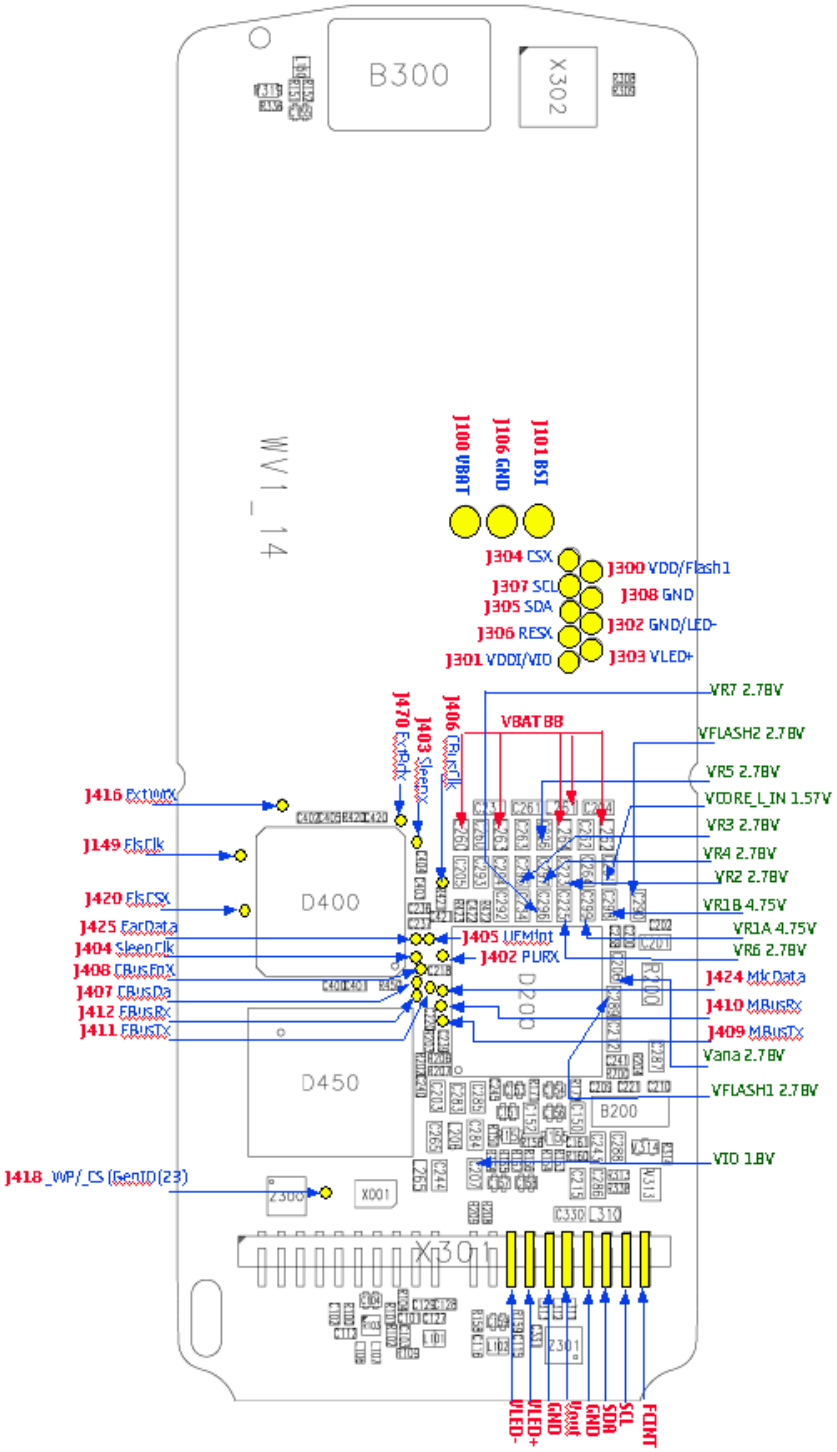

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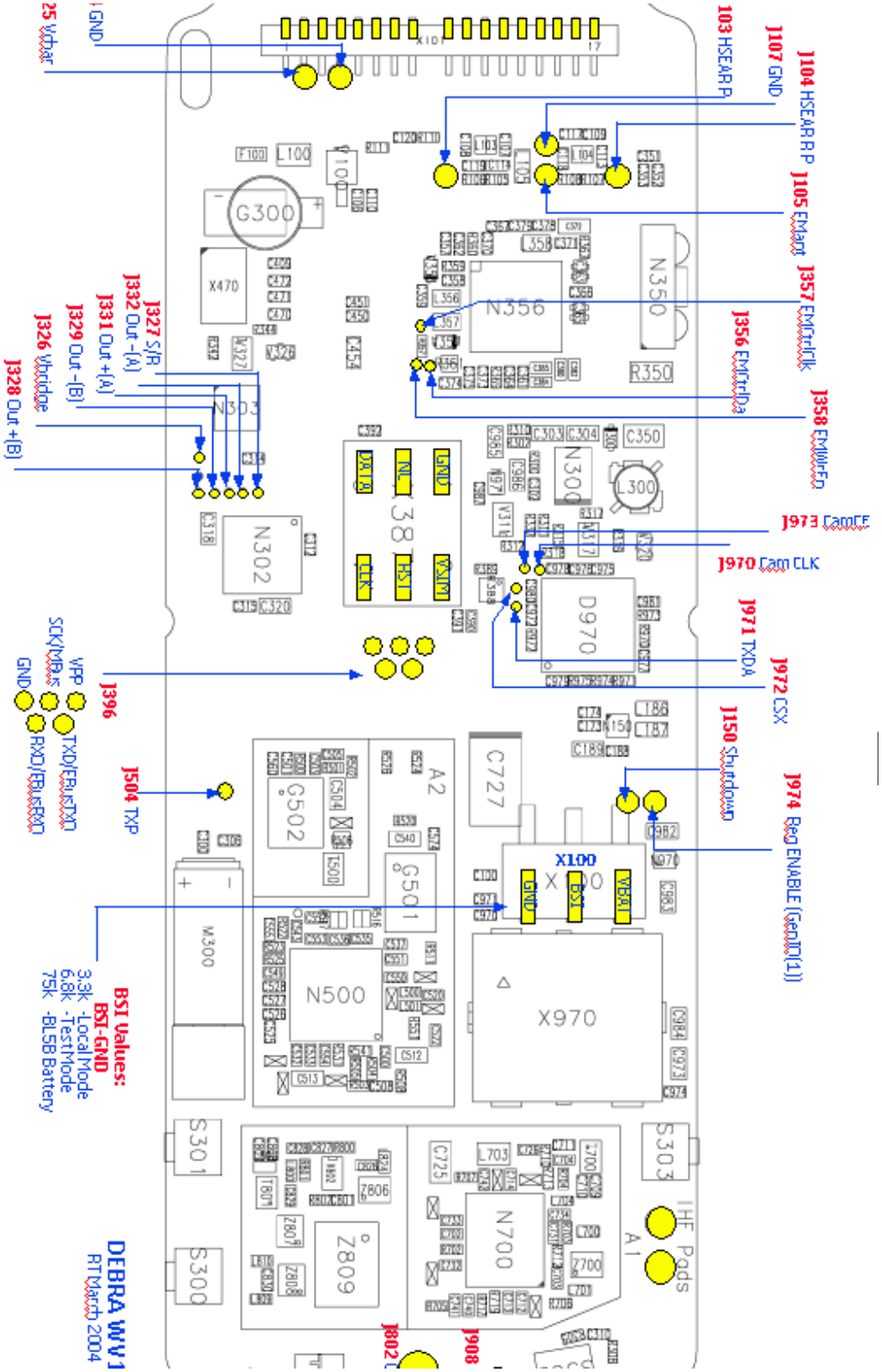
Figure 34: NPL-4/5 BB Measurement Points, Bottom



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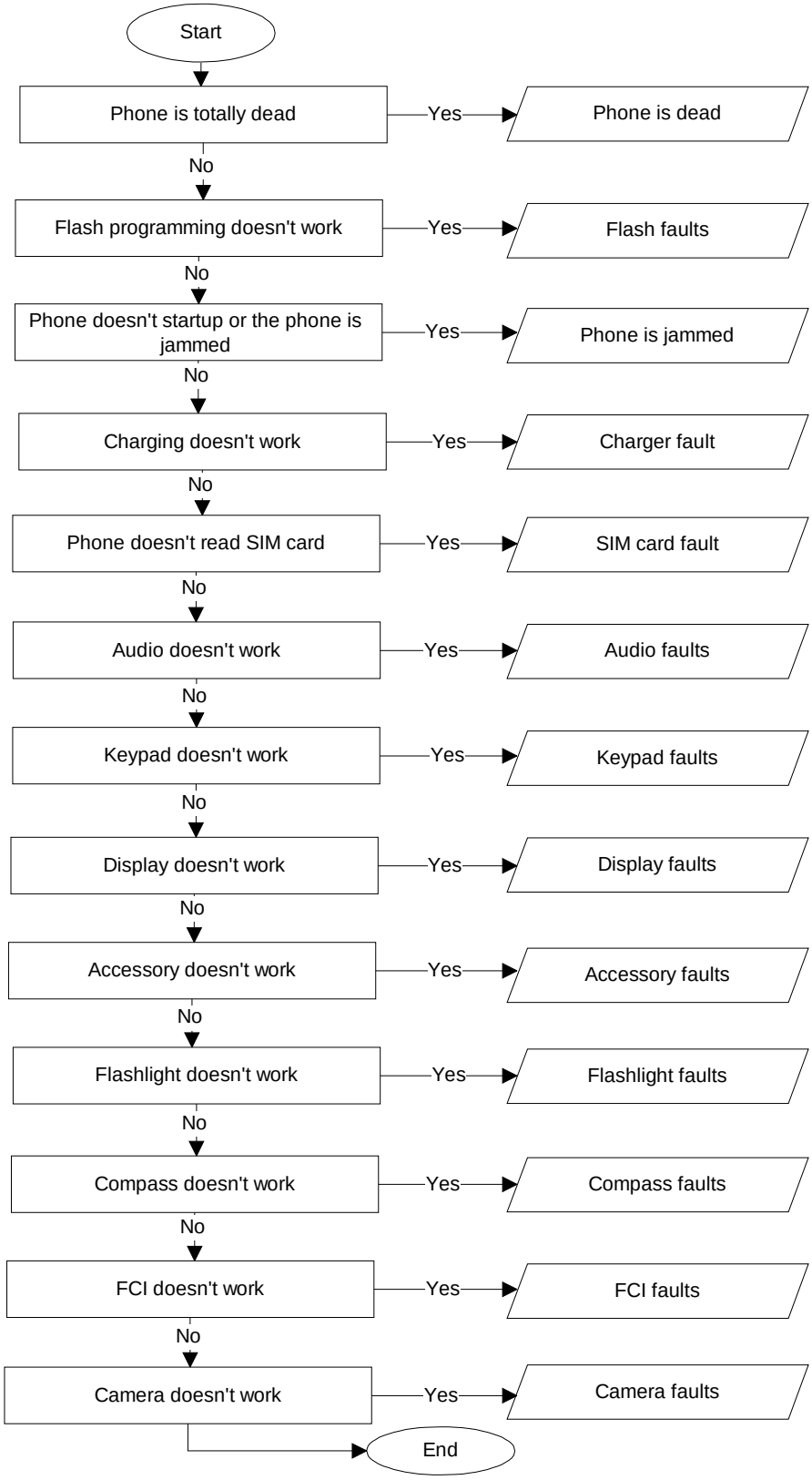
Troubleshooting diagrams

The following diagrams describe baseband troubleshooting:

START:



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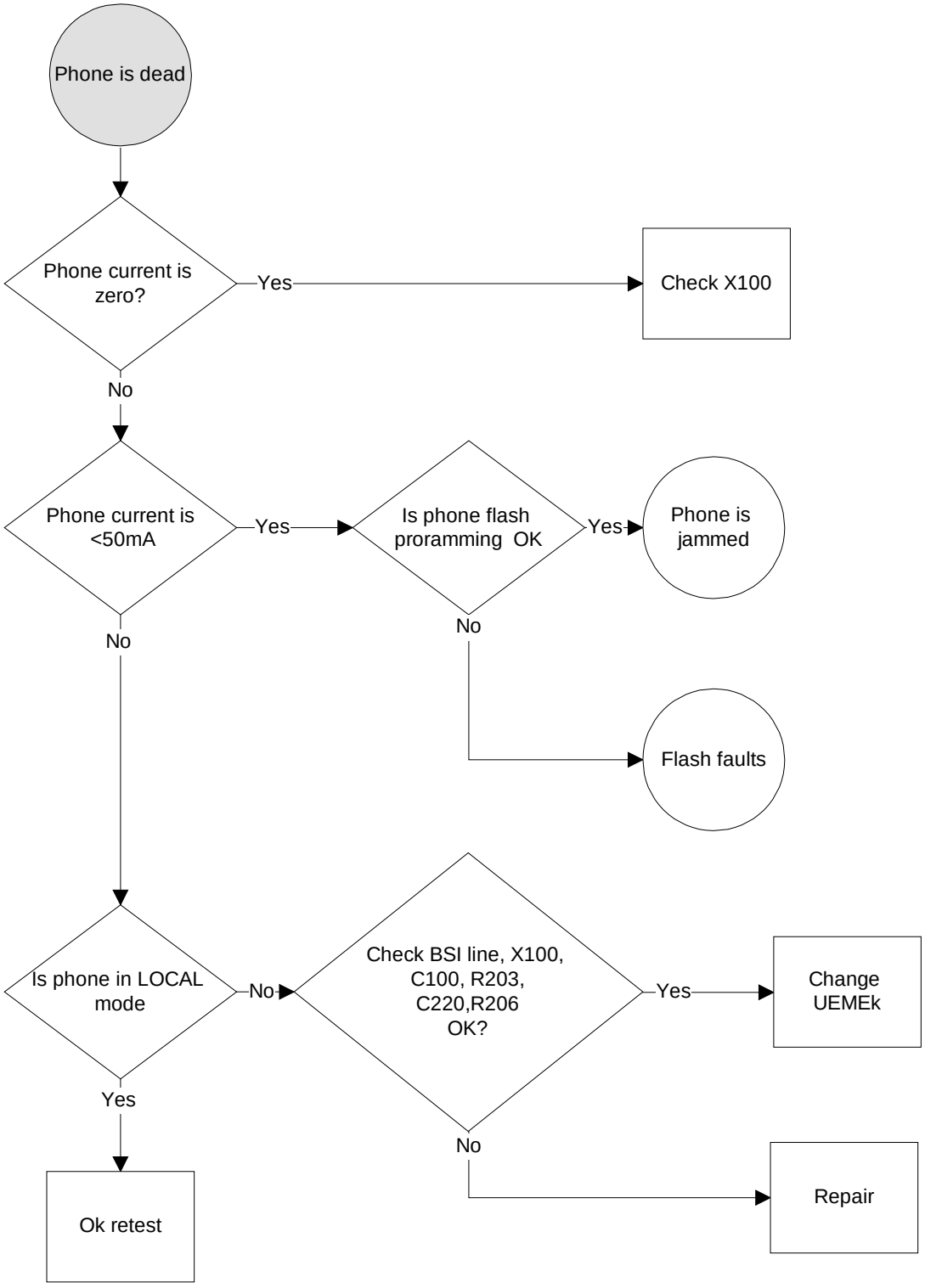
Phone is dead.



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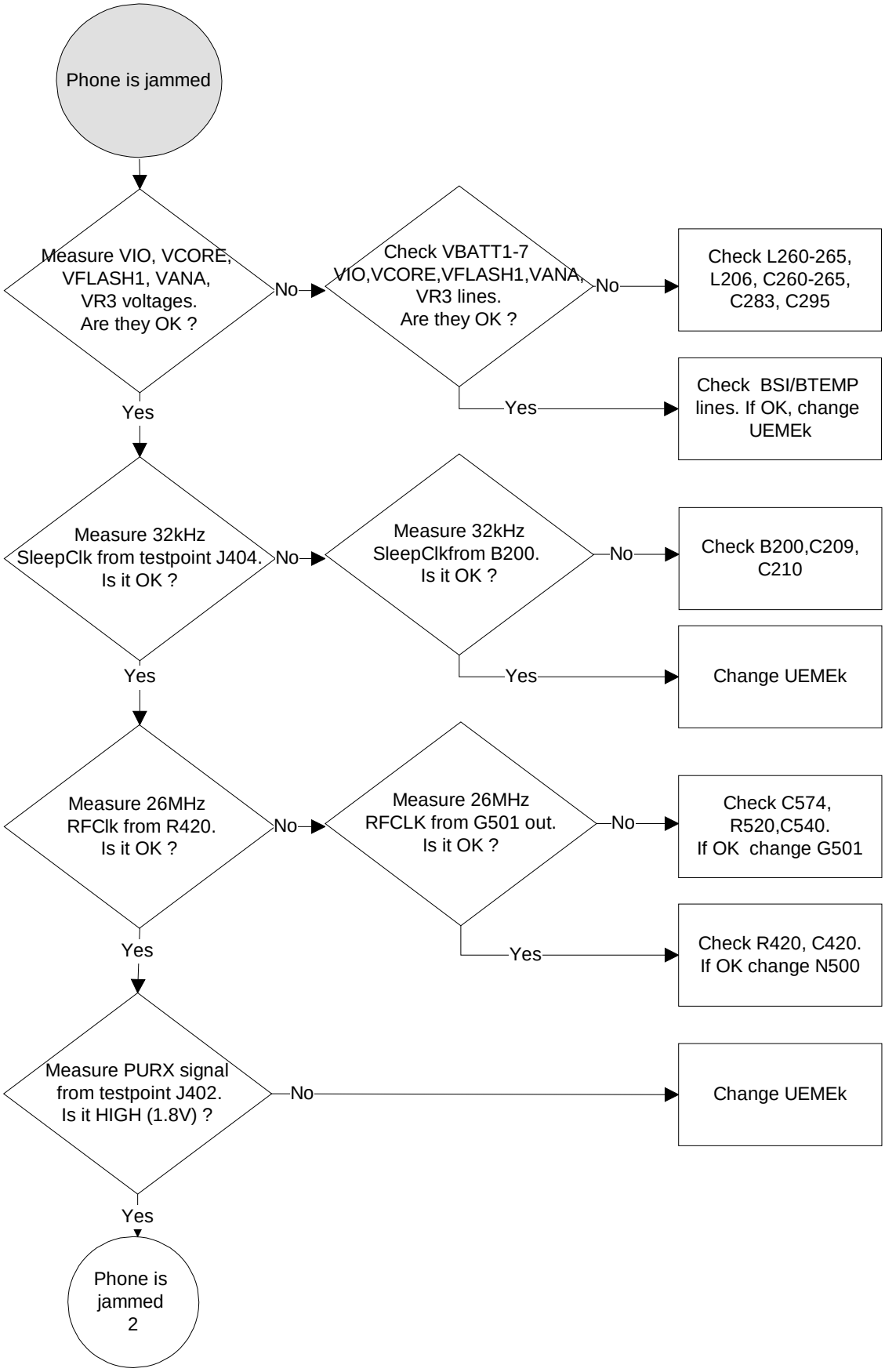
Phone is jammed 1


Phone is jammed
Measure VIO, VCORE, VFLASH1, VANA, VR3 voltages. Are they OK ?
No
Check VBATT1-7 VIO,VCORE,VFLASH1,VANA, VR3 lines. Are they OK ?
No
Check L260-265, L206, C260-265, C283, C295
Yes
Check BSI/BTEMP lines. If OK, change UEMEk
Yes
Measure 32kHz SleepClk from testpoint J404. Is it OK ?
No
Measure 32kHz SleepClkfrom B200. Is it OK ?
No
Check B200,C209, C210
Yes
Change UEMEk
Yes
Measure 26MHz RFClk from R420. Is it OK ?
No
Measure 26MHz RFCLK from G501 out. Is it OK ?
No
Check C574, R520,C540. If OK change G501
Yes
Check R420, C420. If OK change N500
Yes
Measure PURX signal from testpoint J402. Is it HIGH (1.8V) ?
No
Change UEMEk
Yes
Phone is jammed 2

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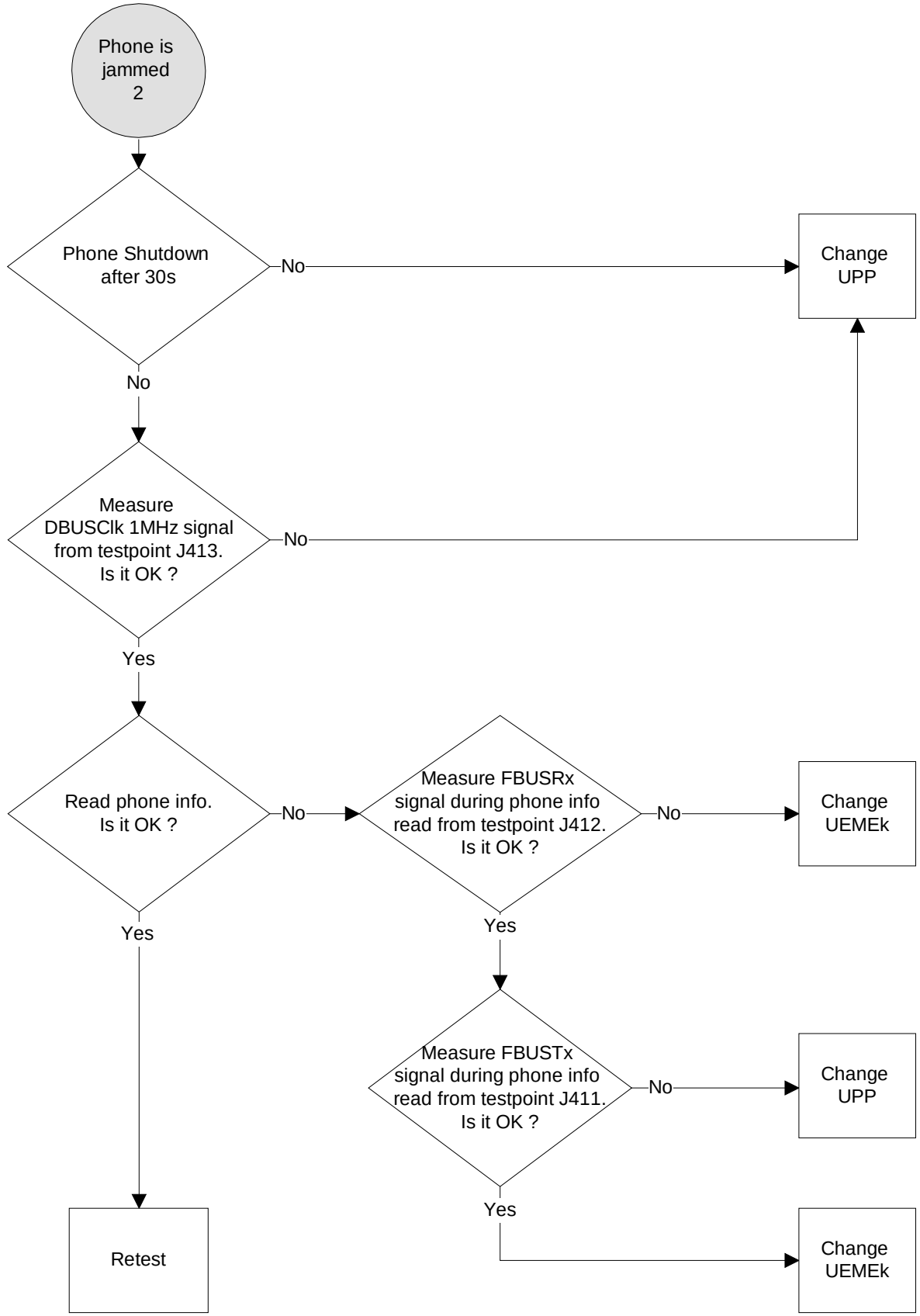
Phone is jammed 2



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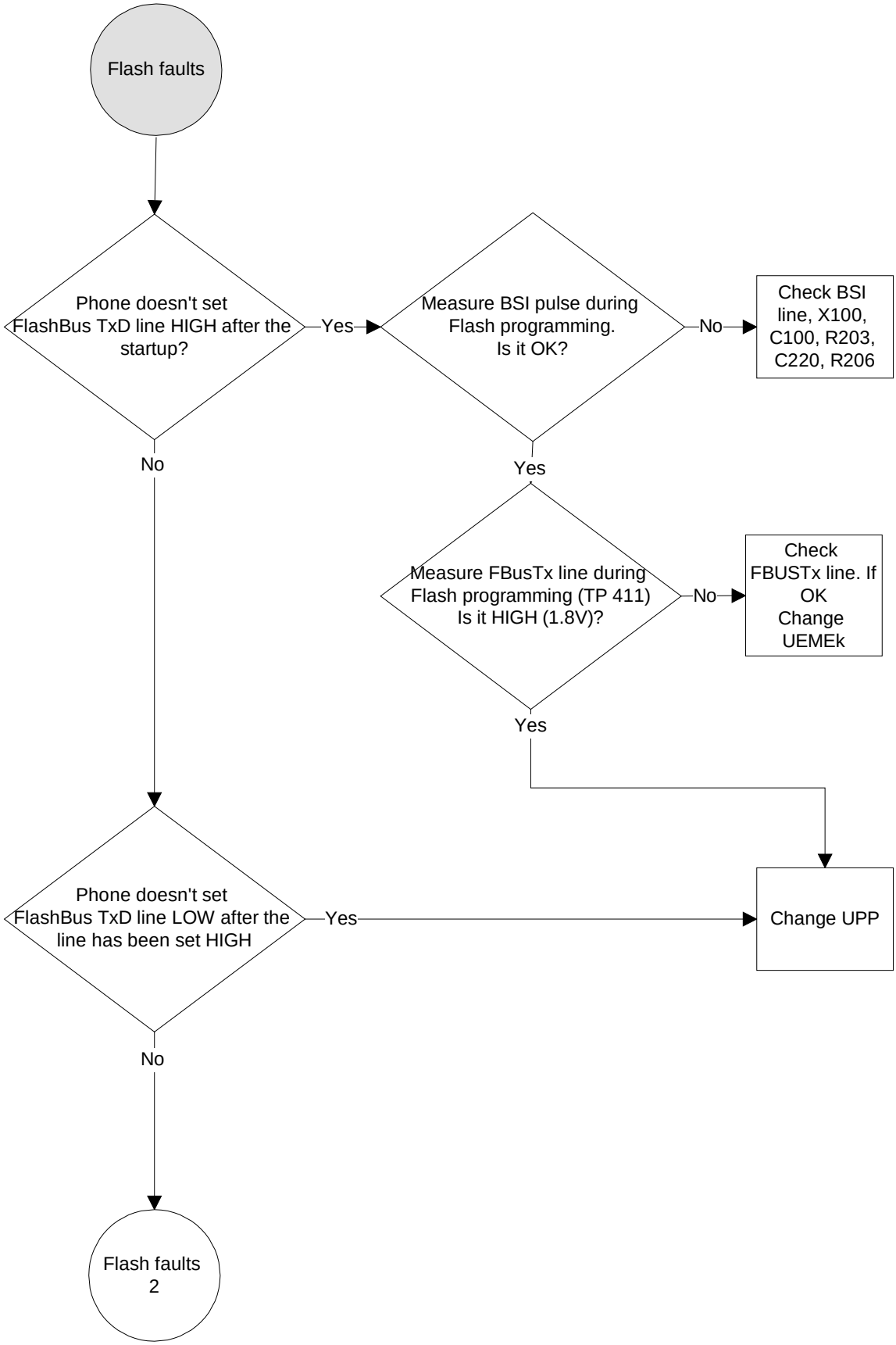
Flash faults 1


Flash faults
Phone doesn't set FlashBus TxD line HIGH after the startup?
Yes
Measure BSI pulse during Flash programming. Is it OK?
No
Check BSI line, X100, C100, R203, C220, R206
No
Yes
Measure FBusTx line during Flash programming (TP 411) Is it HIGH (1.8V)?
No
Check FBUSTx line. If OK Change UEMEk
Yes
Phone doesn't set FlashBus TxD line LOW after the line has been set HIGH
Yes
Change UPP
No
Flash faults 2

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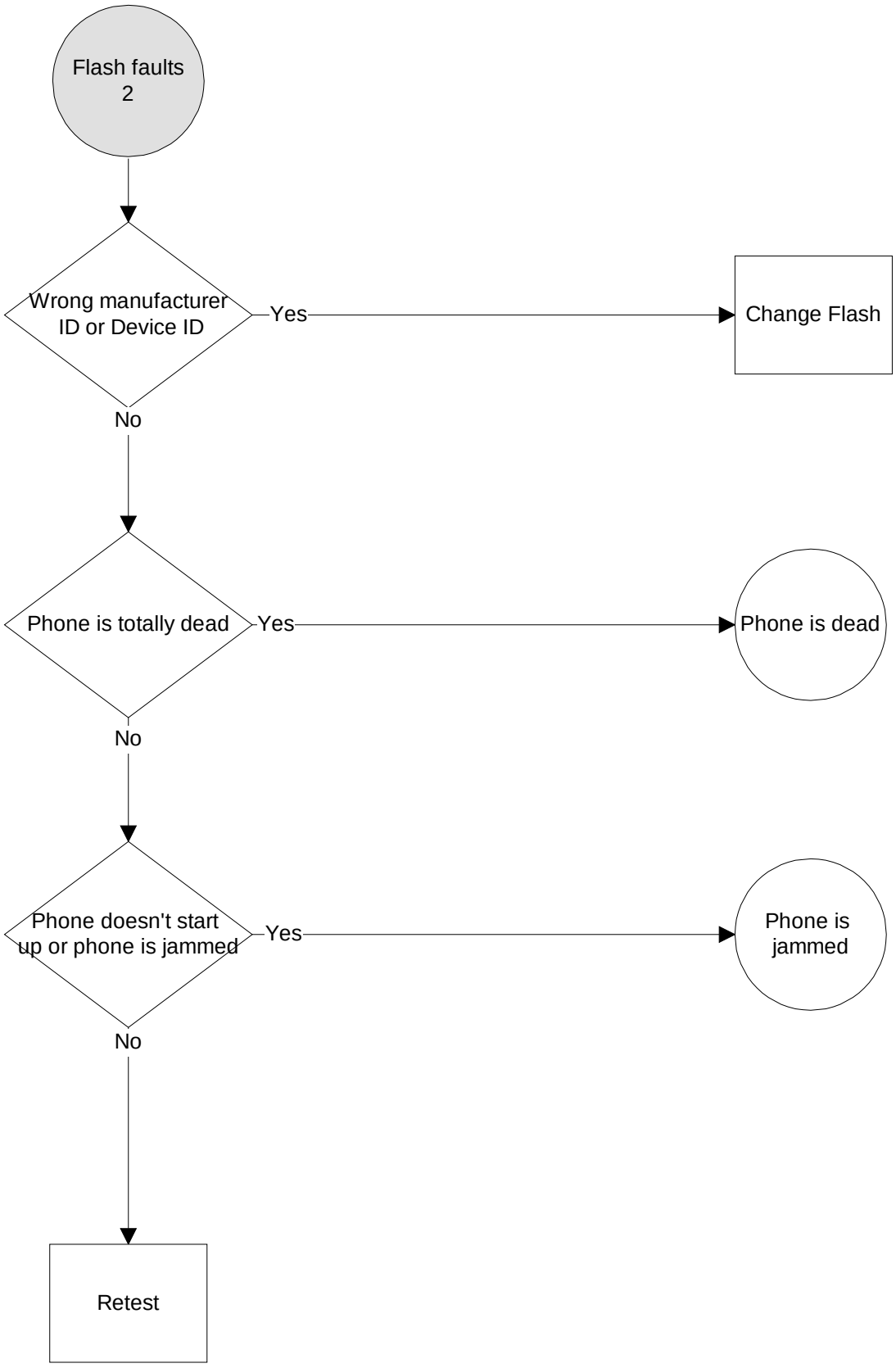
Flash faults 2



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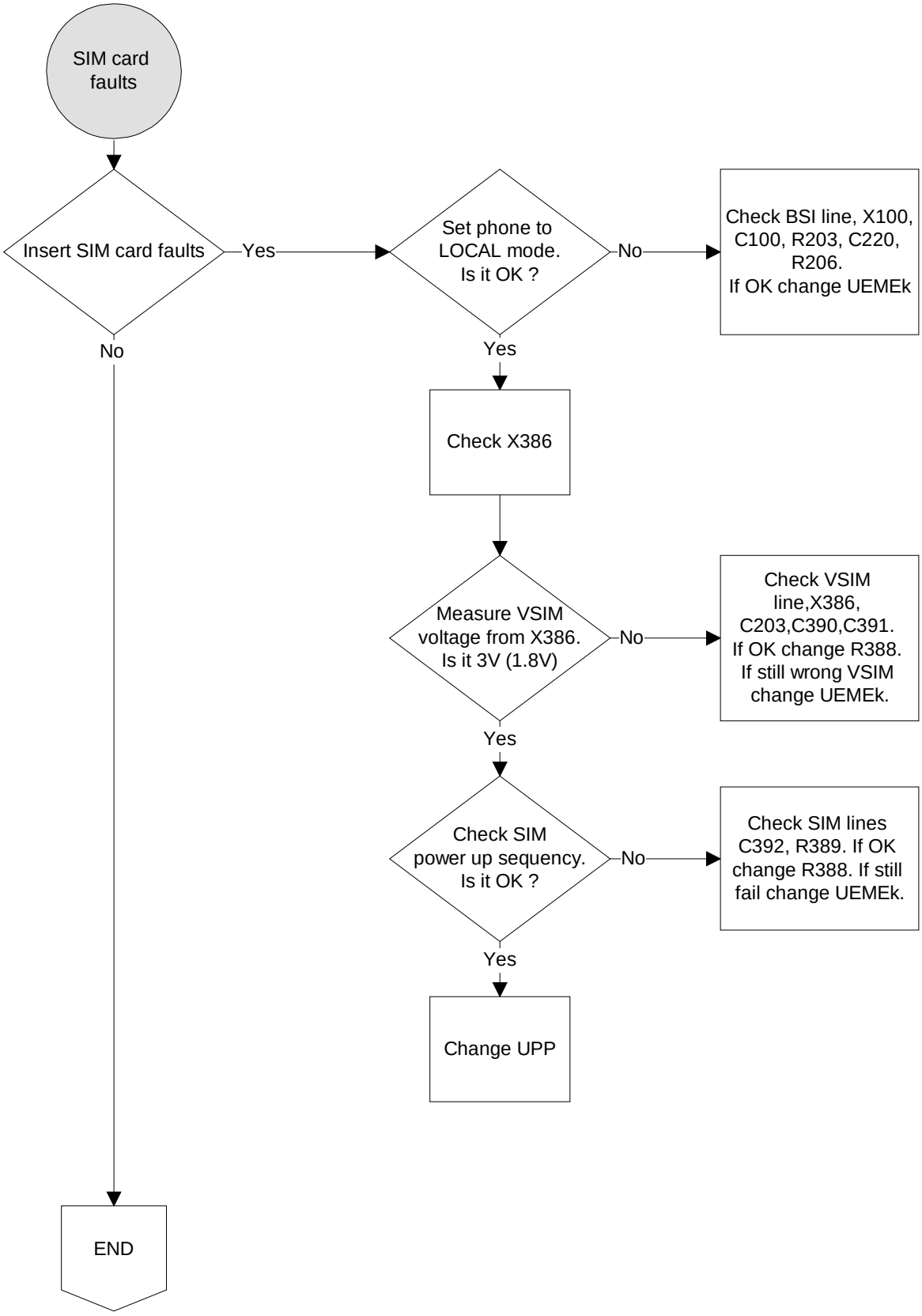
SIM card faults


SIM card faults
Insert SIM card faults
Yes
No
Set phone to LOCAL mode. Is it OK ?
No
Check BSI line, X100, C100, R203, C220, R206. If OK change UEMEk
Yes
Check X386
Measure VSIM voltage from X386. Is it 3V (1.8V)
No
Check VSIM line,X386, C203,C390,C391. If OK change R388. If still wrong VSIM change UEMEk.
Yes
Check SIM power up sequency. Is it OK ?
No
Check SIM lines C392, R389. If OK change R388. If still fail change UEMEk.
Yes
Change UPP
END

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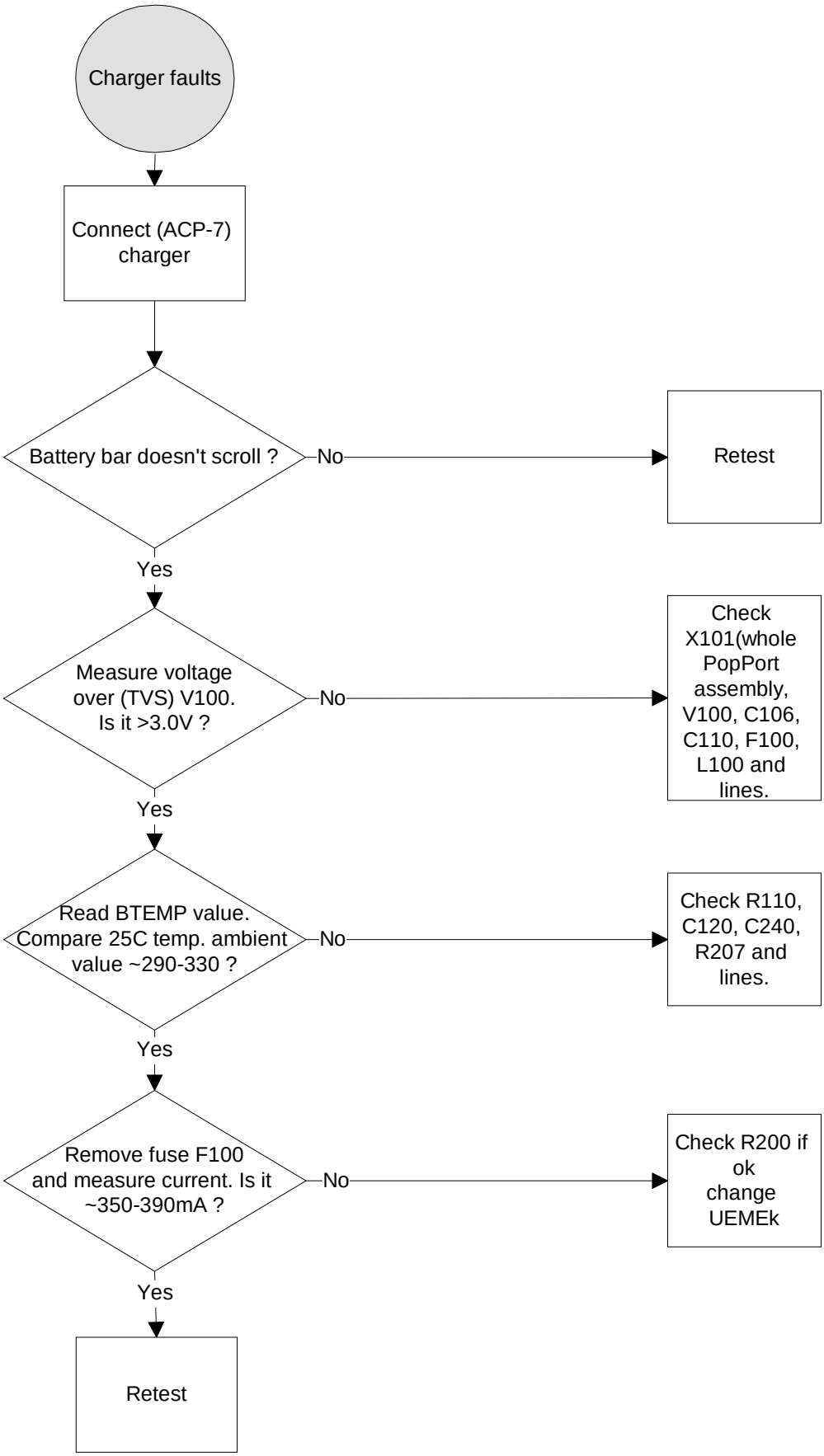
Charger faults



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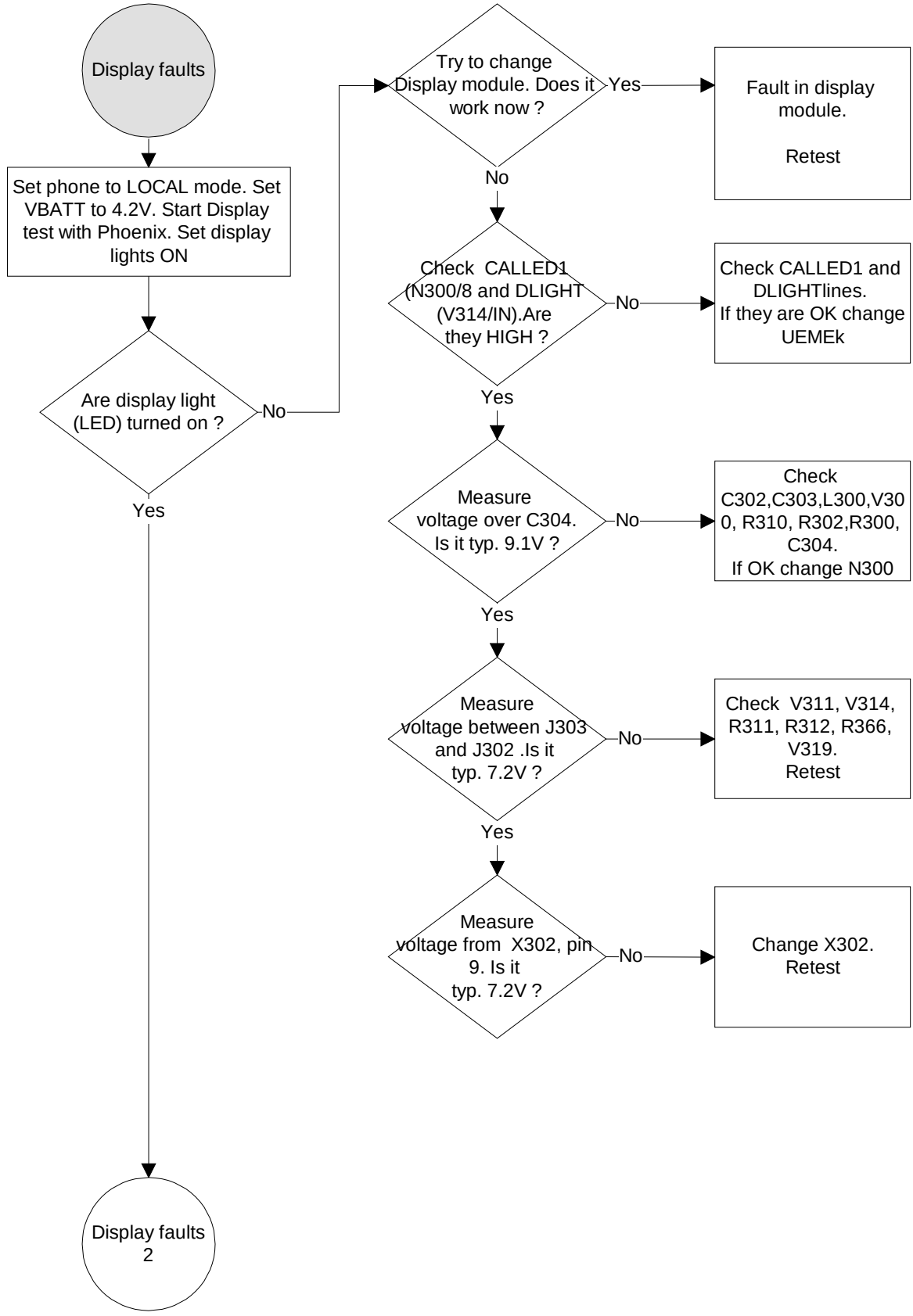
Display faults 1


Display faults
Set phone to LOCAL mode. Set VBATT to 4.2V. Start Display test with Phoenix. Set display lights ON
Are display light (LED) turned on ?
No
Yes
Try to change Display module. Does it work now ?
Yes
Fault in display module.
Retest
No
Check CALLED1 (N300/8 and DLIGHT (V314/IN).Are they HIGH ?
No
Check CALLED1 and DLIGHTlines. If they are OK change UEMEk
Yes
Measure voltage over C304. Is it typ. 9.1V ?
No
Check C302,C303,L300,V300, R310, R302,R300, C304. If OK change N300
Yes
Measure voltage between J303 and J302 .Is it typ. 7.2V ?
No
Check V311, V314, R311, R312, R366, V319. Retest
Yes
Measure voltage from X302, pin 9. Is it typ. 7.2V ?
No
Change X302. Retest
Display faults 2

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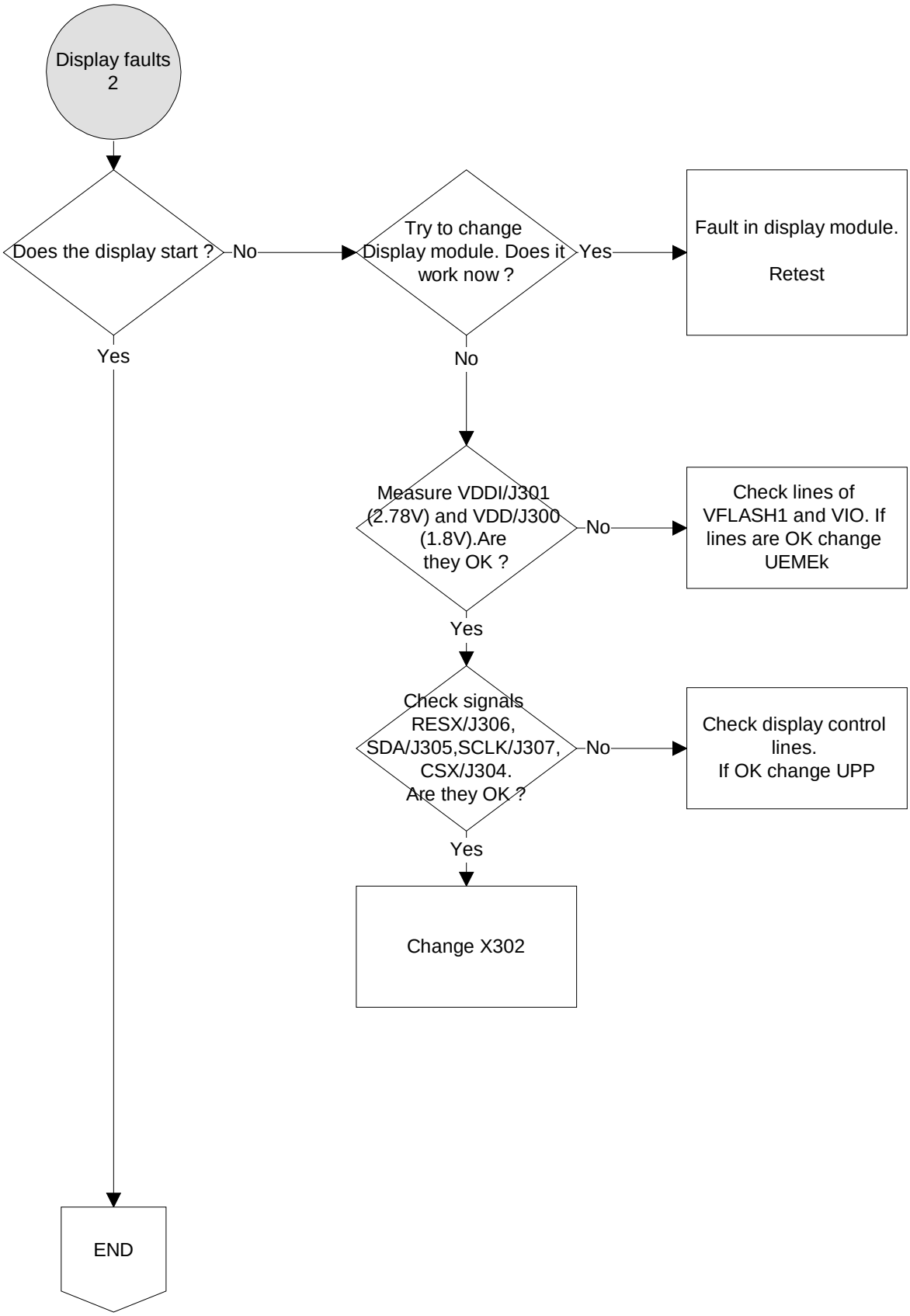
Display faults 2



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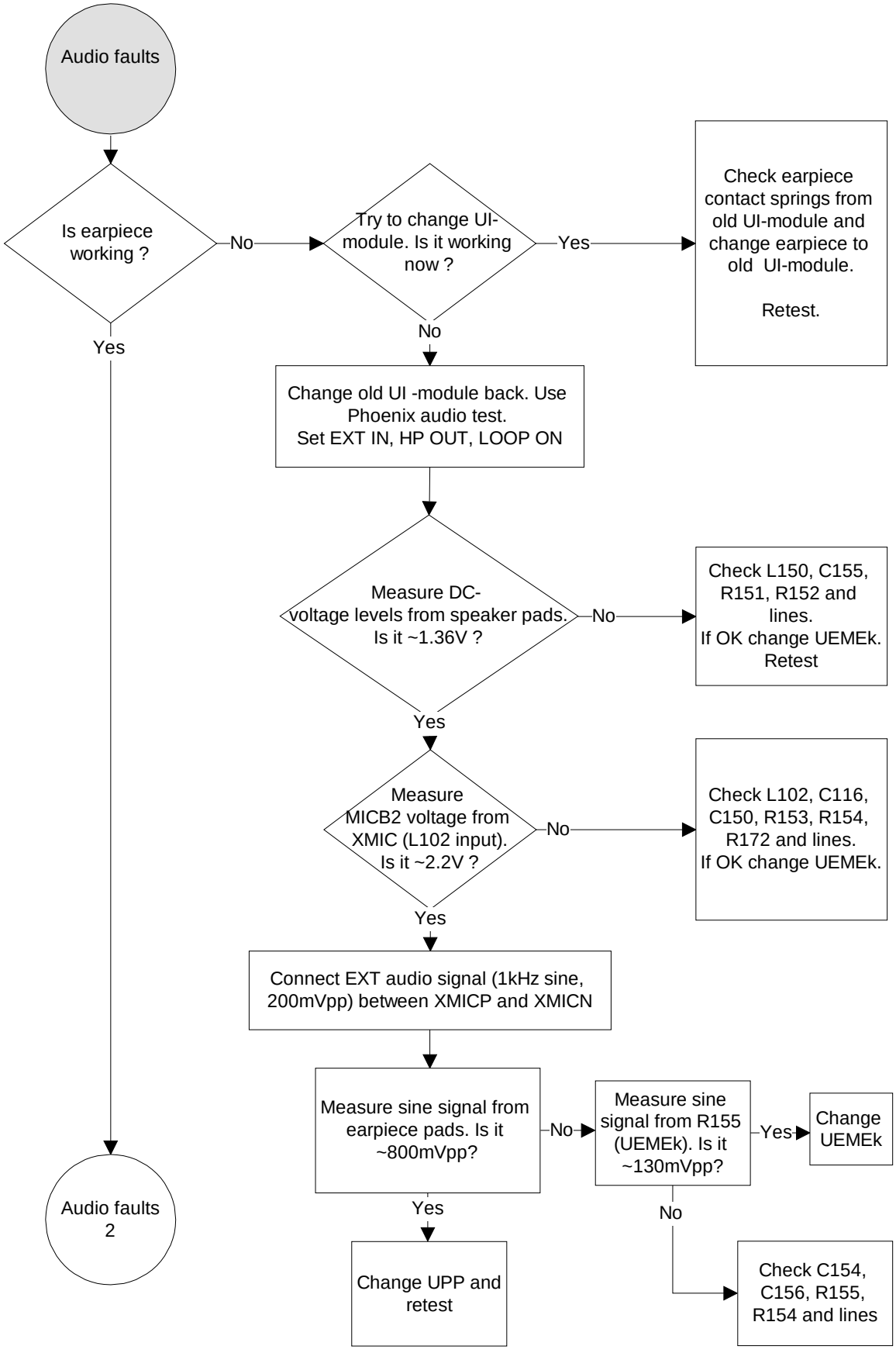
Audio fault1


Audio faults
Is earpiece working ?
No
Try to change UI-module. Is it working now ?
Yes
Check earpiece contact springs from old UI-module and change earpiece to old UI-module.
Retest.
No
Yes
Change old UI -module back. Use Phoenix audio test.
Set EXT IN, HP OUT, LOOP ON
Measure DC-voltage levels from speaker pads. Is it ~1.36V ?
No
Check L150, C155, R151, R152 and lines.
If OK change UEMEk.
Retest
Yes
Measure MICB2 voltage from XMIC (L102 input). Is it ~2.2V ?
No
Check L102, C116, C150, R153, R154, R172 and lines.
If OK change UEMEk.
Yes
Connect EXT audio signal (1kHz sine, 200mVpp) between XMICP and XMICN
Measure sine signal from earpiece pads. Is it ~800mVpp?
No
Measure sine signal from R155 (UEMEk). Is it ~130mVpp?
Yes
Change UEMEk
Yes
No
Change UPP and retest
Check C154, C156, R155, R154 and lines
Audio faults 2

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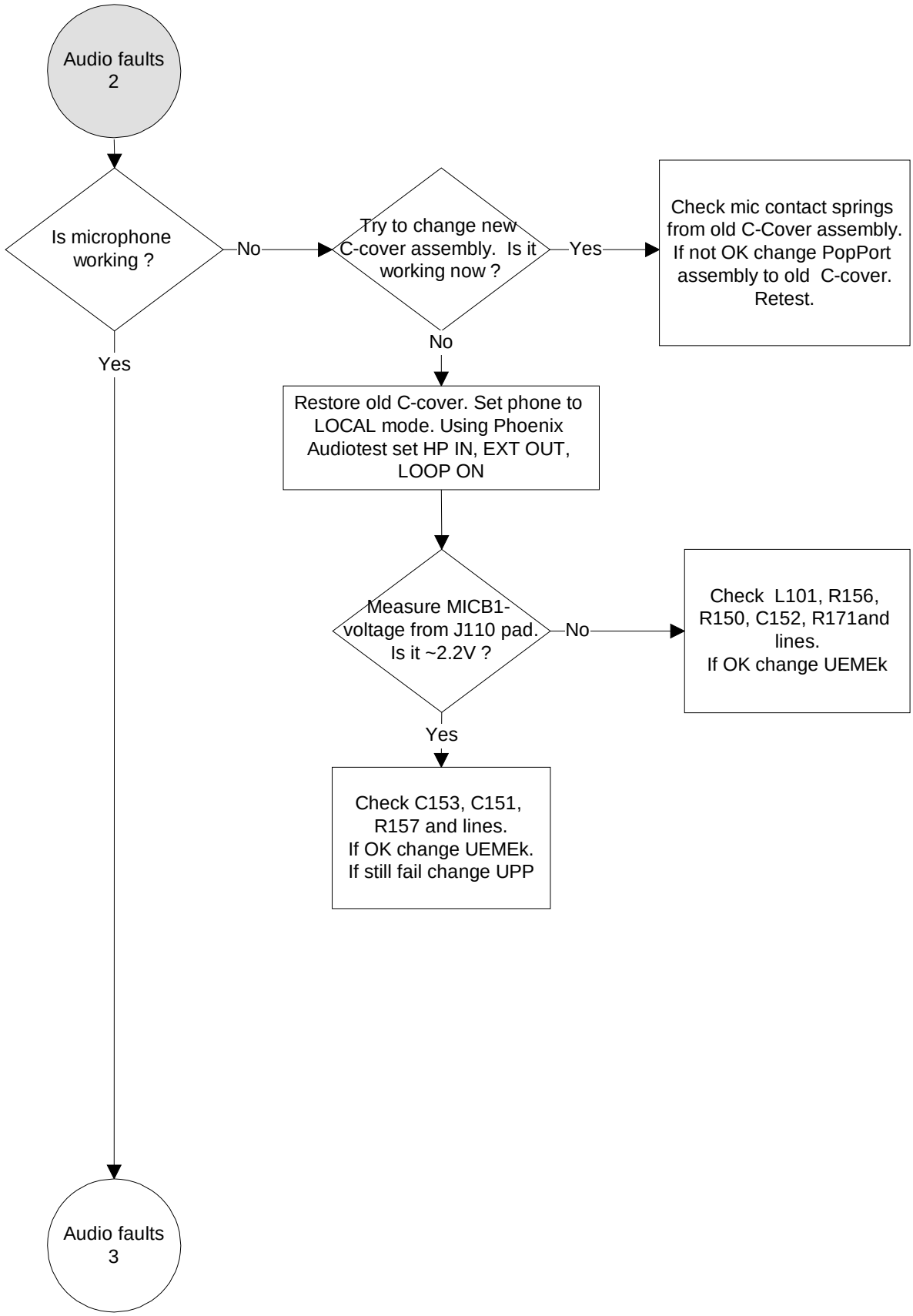
Audio fault 2


Audio faults 2
Is microphone working ?
No
Try to change new C-cover assembly. Is it working now ?
Yes
Check mic contact springs from old C-Cover assembly. If not OK change PopPort assembly to old C-cover. Retest.
No
Yes
Restore old C-cover. Set phone to LOCAL mode. Using Phoenix Audiotest set HP IN, EXT OUT, LOOP ON
Measure MICB1-voltage from J110 pad. Is it ~2.2V ?
No
Check L101, R156, R150, C152, R171and lines. If OK change UEMEk
Yes
Check C153, C151, R157 and lines. If OK change UEMEk. If still fail change UPP
Audio faults 3

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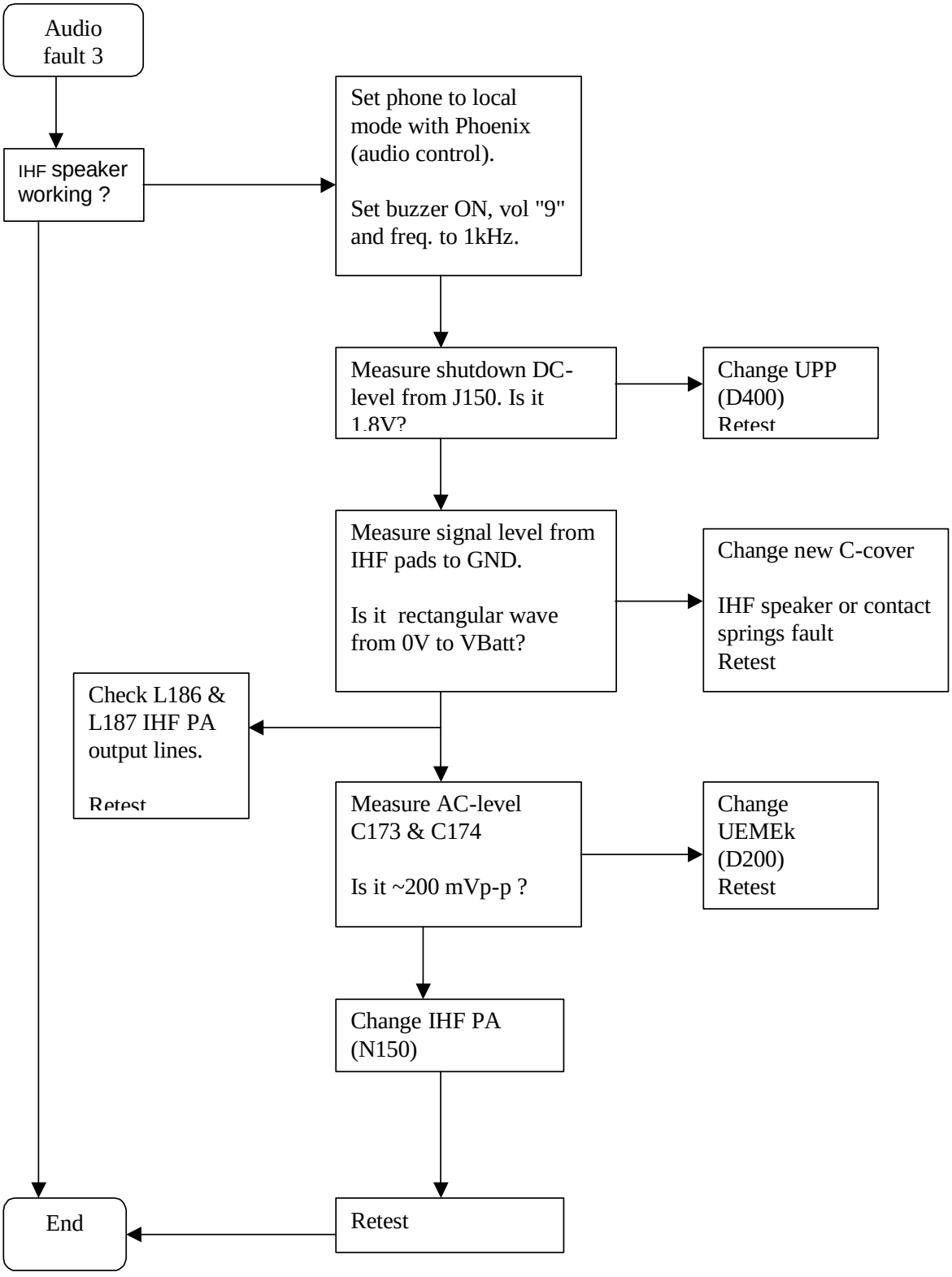
Audio fault 3


Audio fault 3
IHF speaker working ?
Set phone to local mode with Phoenix (audio control).
Set buzzer ON, vol "9" and freq. to 1kHz.
Measure shutdown DC-level from J150. Is it 1.8V?
Change UPP (D400)
Retest
Measure signal level from IHF pads to GND.
Is it rectangular wave from 0V to VBatt?
Change new C-cover
IHF speaker or contact springs fault
Retest
Check L186 & L187 IHF PA output lines.
Retest
Measure AC-level C173 & C174
Is it ~200 mVp-p ?
Change UEMEk (D200)
Retest
Change IHF PA (N150)
Retest
End

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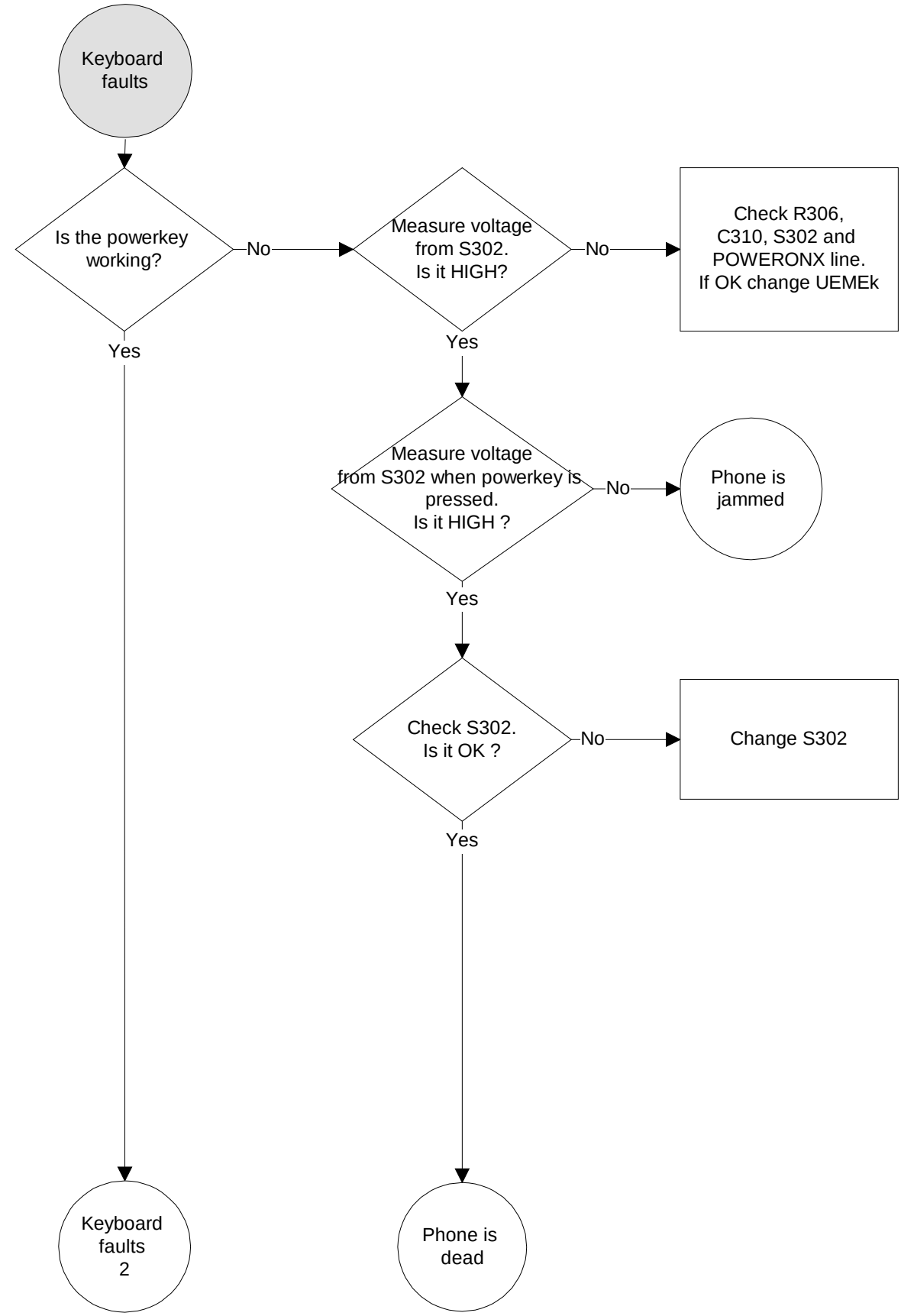
Keyboard faults 1



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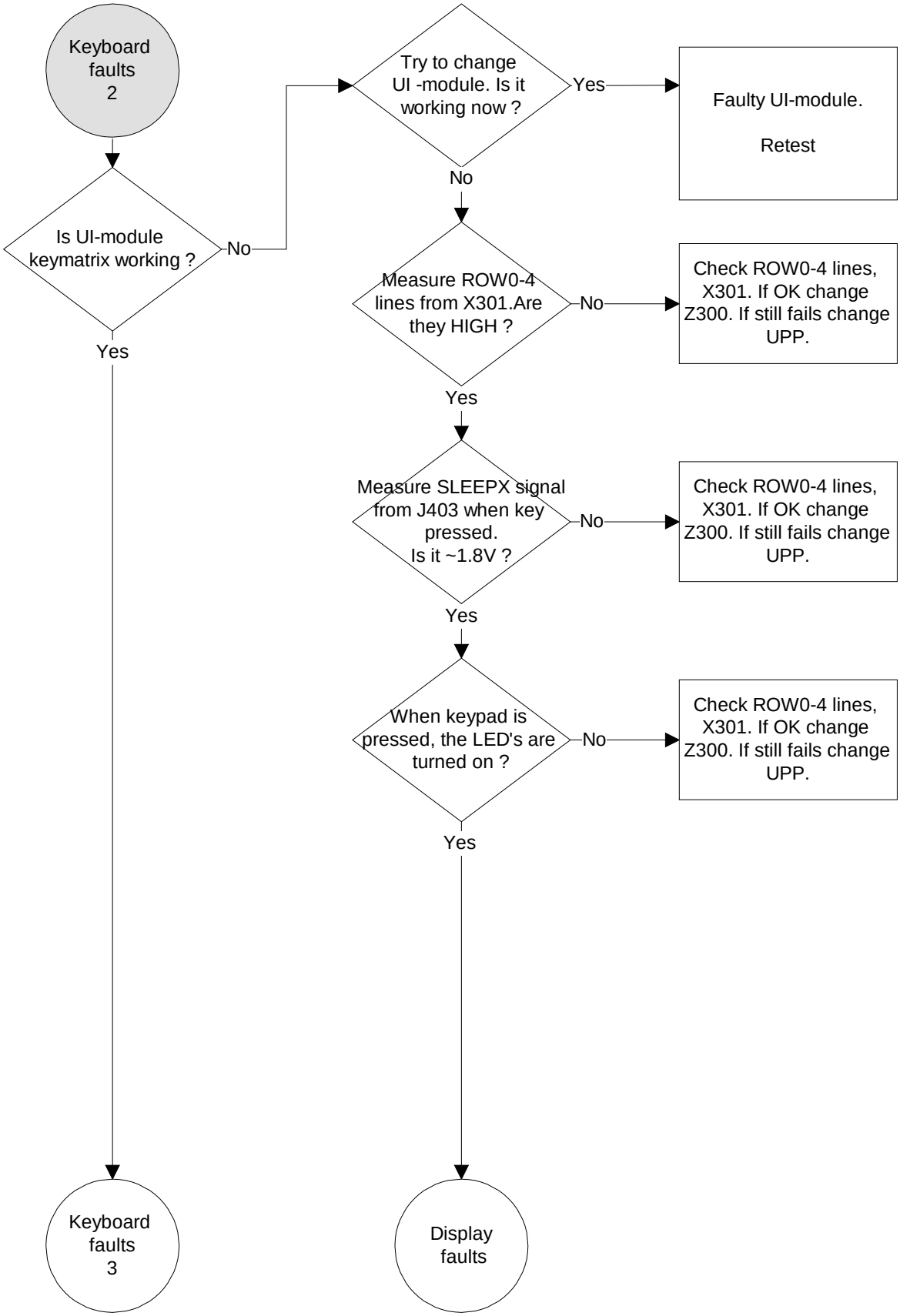
Keyboard faults 2


Keyboard faults 2
Is UI-module keymatrix working ?
No
Yes
Try to change UI -module. Is it working now ?
Yes
Faulty UI-module.
Retest
No
Measure ROW0-4 lines from X301.Are they HIGH ?
No
Check ROW0-4 lines, X301. If OK change Z300. If still fails change UPP.
Yes
Measure SLEEPX signal from J403 when key pressed. Is it ~1.8V ?
No
Check ROW0-4 lines, X301. If OK change Z300. If still fails change UPP.
Yes
When keypad is pressed, the LED's are turned on ?
No
Check ROW0-4 lines, X301. If OK change Z300. If still fails change UPP.
Yes
Keyboard faults 3
Display faults

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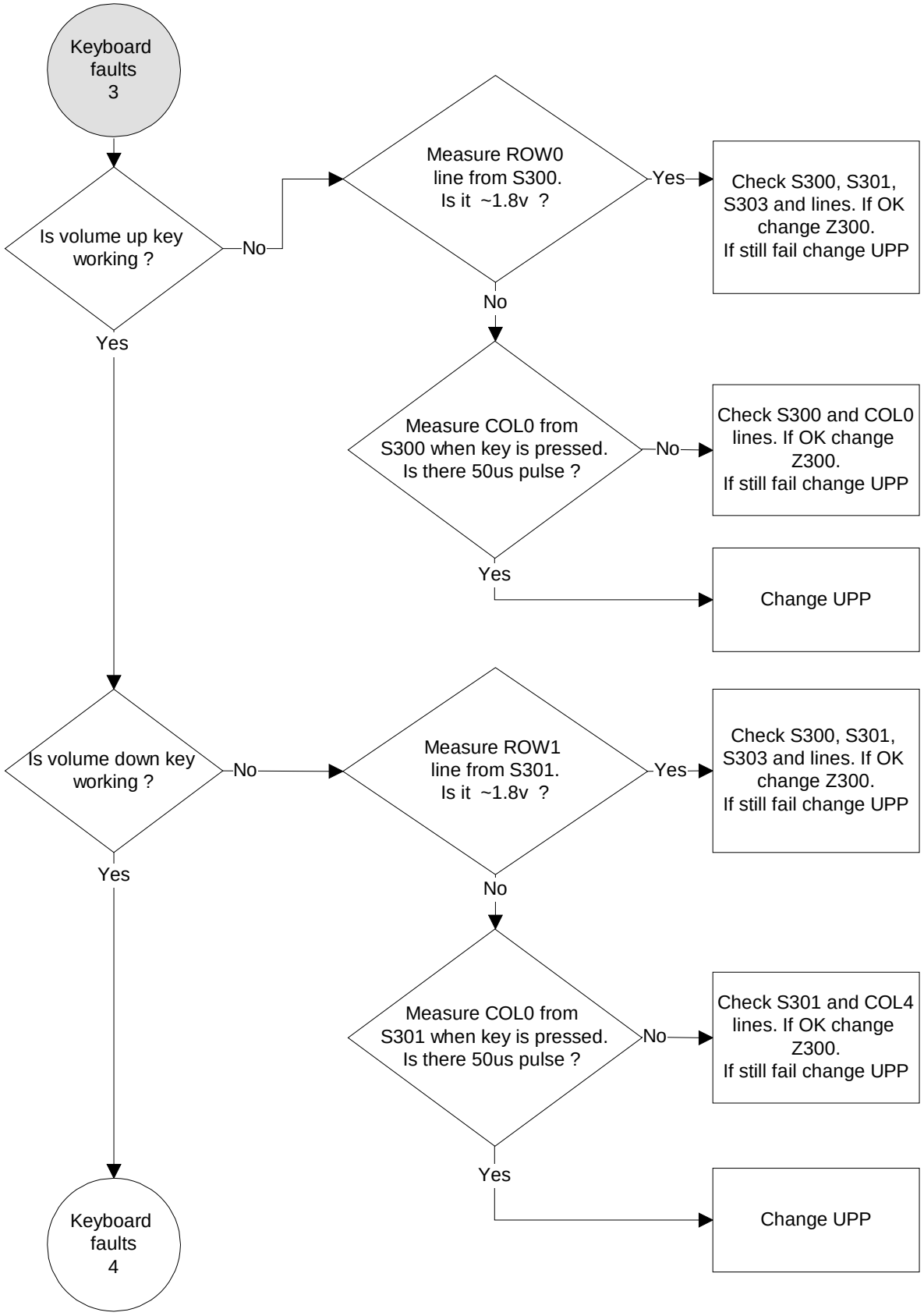
Keyboard faults 3


Keyboard faults 3
Is volume up key working ?
No
Measure ROW0 line from S300. Is it ~1.8v ?
Yes
Check S300, S301, S303 and lines. If OK change Z300. If still fail change UPP
No
Yes
Measure COL0 from S300 when key is pressed. Is there 50us pulse ?
No
Check S300 and COL0 lines. If OK change Z300. If still fail change UPP
Yes
Change UPP
Is volume down key working ?
No
Measure ROW1 line from S301. Is it ~1.8v ?
Yes
Check S300, S301, S303 and lines. If OK change Z300. If still fail change UPP
Yes
No
Measure COL0 from S301 when key is pressed. Is there 50us pulse ?
No
Check S301 and COL4 lines. If OK change Z300. If still fail change UPP
Yes
Change UPP
Keyboard faults 4

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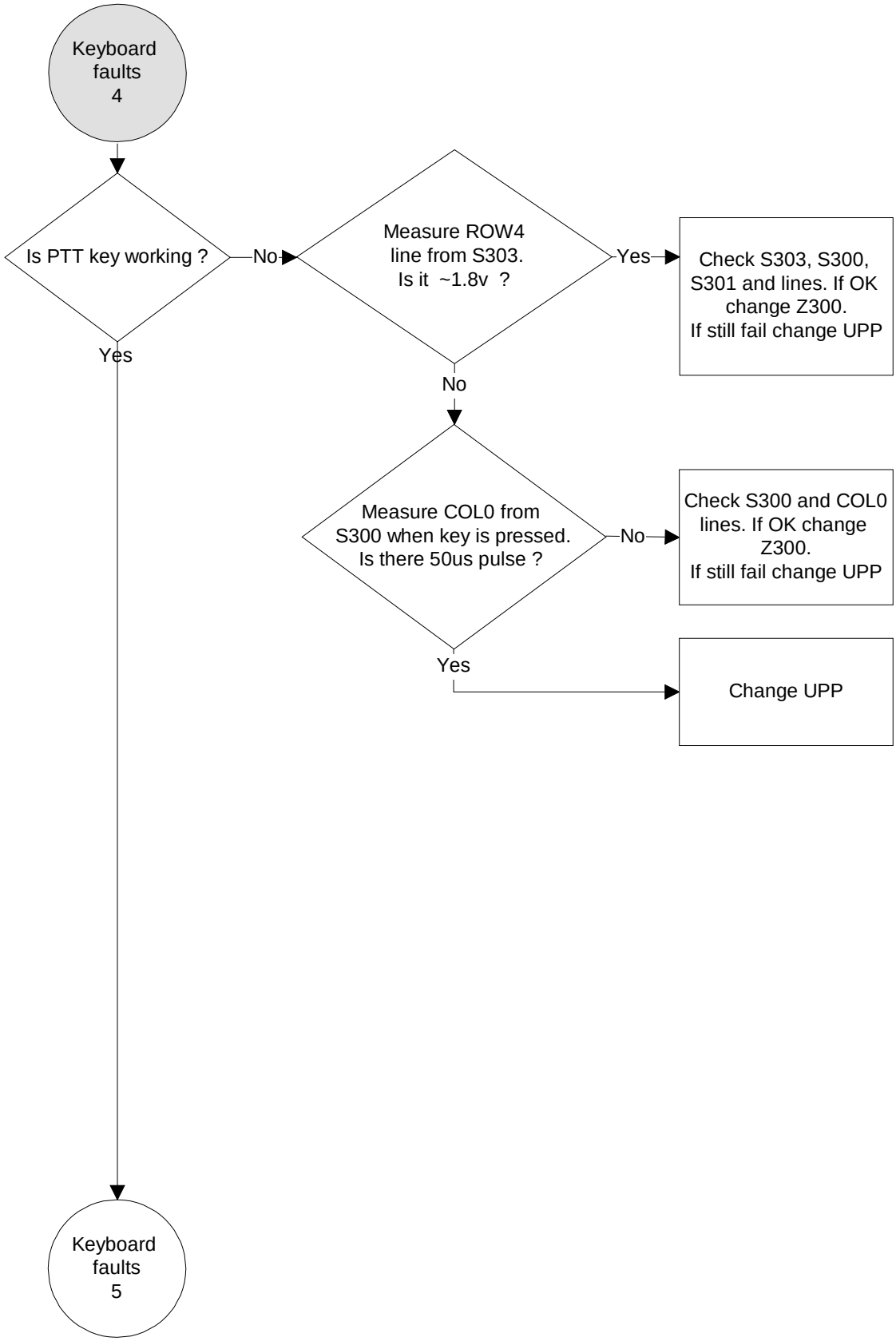
Keyboard faults 4


Keyboard faults 4
Is PTT key working ?
No
Measure ROW4 line from S303. Is it ~1.8v ?
Yes
Check S303, S300, S301 and lines. If OK change Z300. If still fail change UPP
Yes
No
Measure COL0 from S300 when key is pressed. Is there 50us pulse ?
No
Check S300 and COL0 lines. If OK change Z300. If still fail change UPP
Yes
Change UPP
Keyboard faults 5

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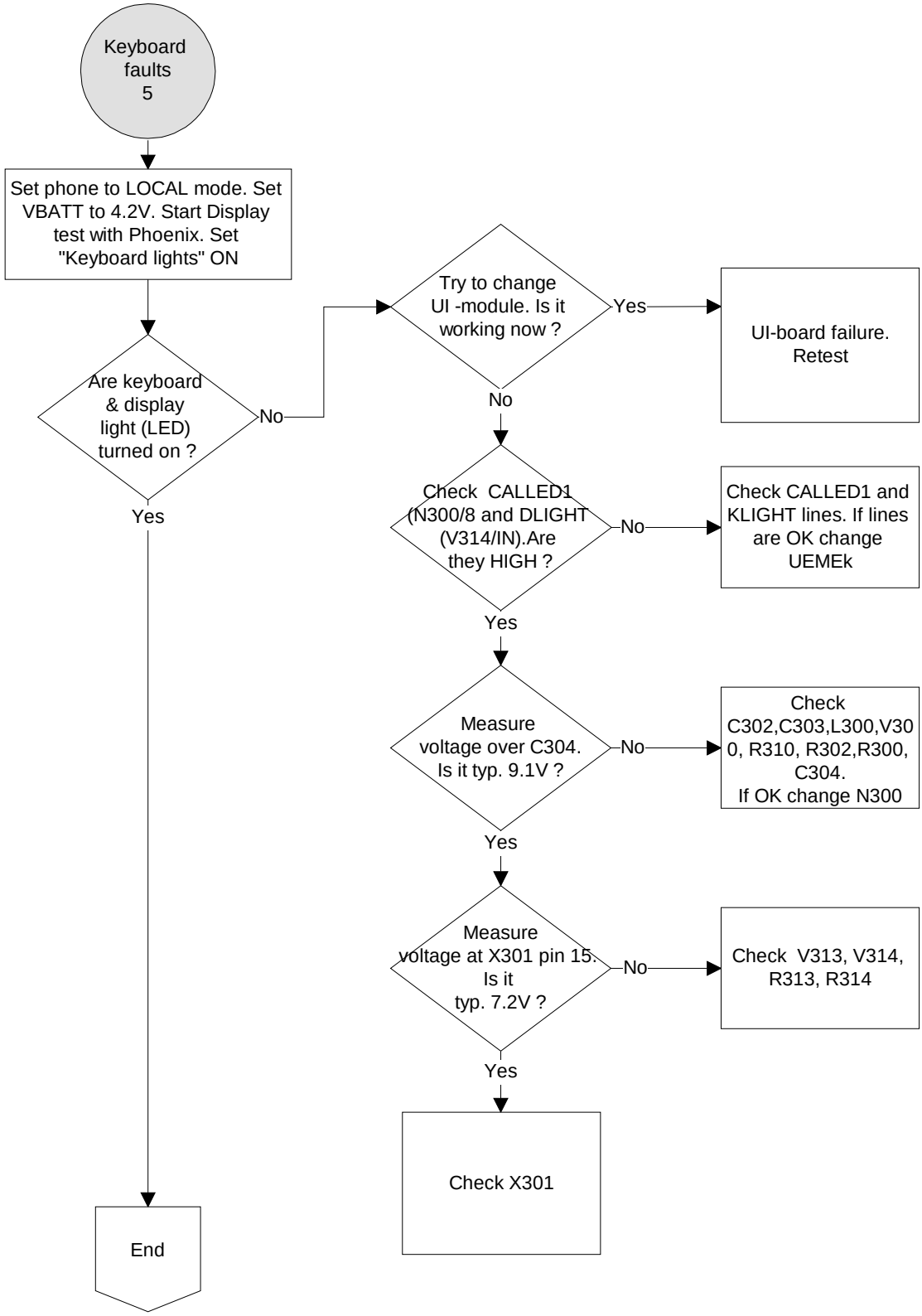
Keyboard faults 5


Keyboard faults 5
Set phone to LOCAL mode. Set VBATT to 4.2V. Start Display test with Phoenix. Set "Keyboard lights" ON
Are keyboard & display light (LED) turned on ?
No
Yes
Try to change UI -module. Is it working now ?
Yes
UI-board failure. Retest
No
Check CALLED1 (N300/8 and DLIGHT (V314/IN).Are they HIGH ?
No
Check CALLED1 and KLIGHT lines. If lines are OK change UEMEk
Yes
Measure voltage over C304. Is it typ. 9.1V ?
No
Check C302,C303,L300,V300, R310, R302,R300, C304. If OK change N300
Yes
Measure voltage at X301 pin 15. Is it typ. 7.2V ?
No
Check V313, V314, R313, R314
Yes
Check X301
End

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Accessory faults1

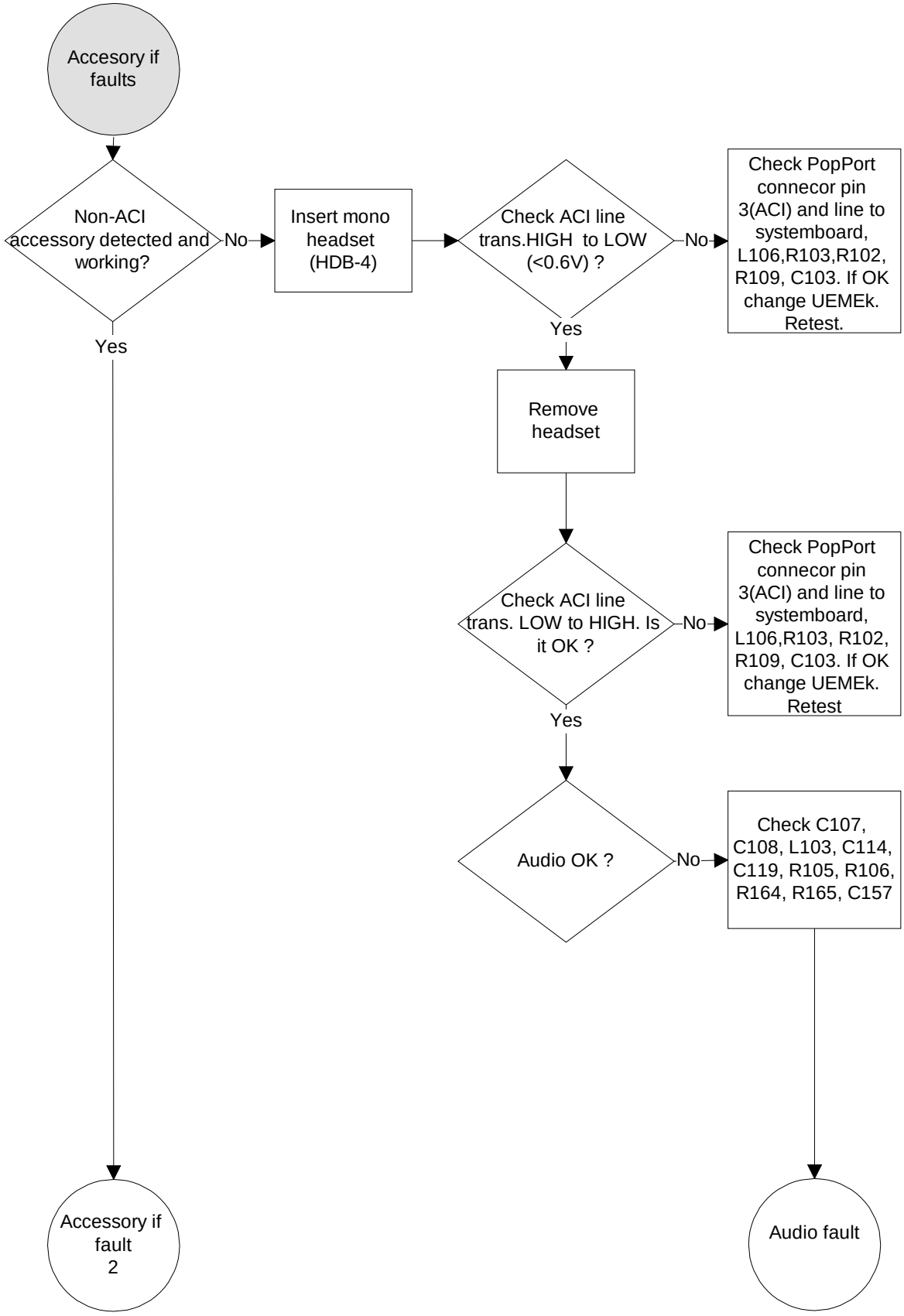
Accesory if faults
Non-ACI accessory detected and working?
No
Insert mono headset (HDB-4)
Check ACI line trans.HIGH to LOW (<0.6V) ?
No
Check PopPort connecor pin 3(ACI) and line to systemboard, L106,R103,R102, R109, C103. If OK change UEMEk. Retest.
Yes
Yes
Remove headset
Check ACI line trans. LOW to HIGH. Is it OK ?
No
Check PopPort connecor pin 3(ACI) and line to systemboard, L106,R103, R102, R109, C103. If OK change UEMEk. Retest
Yes
Audio OK ?
No
Check C107, C108, L103, C114, C119, R105, R106, R164, R165, C157
Accessory if fault 2
Audio fault

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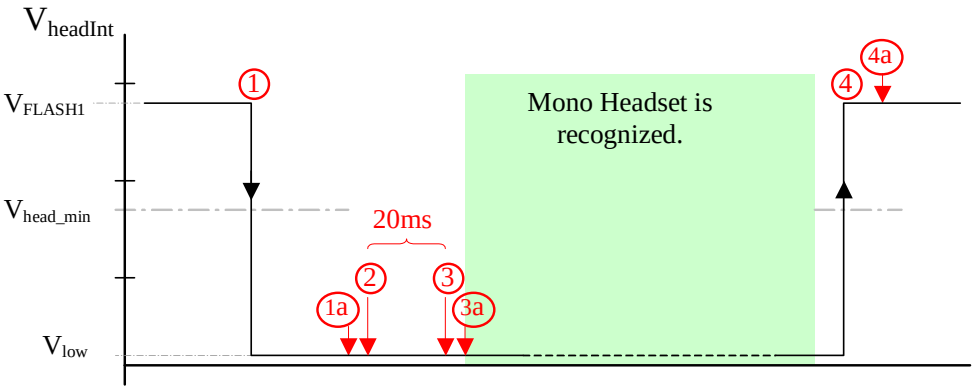
Figure 35: MBUS



1. Accessory is connected (insertion & removal resistor connect to ACI line)
1a) phone gets HeadInt interrupt after 20ms check that ACI line is still low (<Vhead min)
2. Connect MBUS with HeadInt line (MBUS switch)
3. The 20 ms timer elapsed and no transition has been on HeadInt line
3a) Disconnect MBUS from HeadInt line
4. Accessory is removed. Phone gets HeadInt interrupt from ACI line low to high transition.
4a) If no HeadInt interrupt comes in the next 100ms the accessory is really removed.

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Accessory faults 2

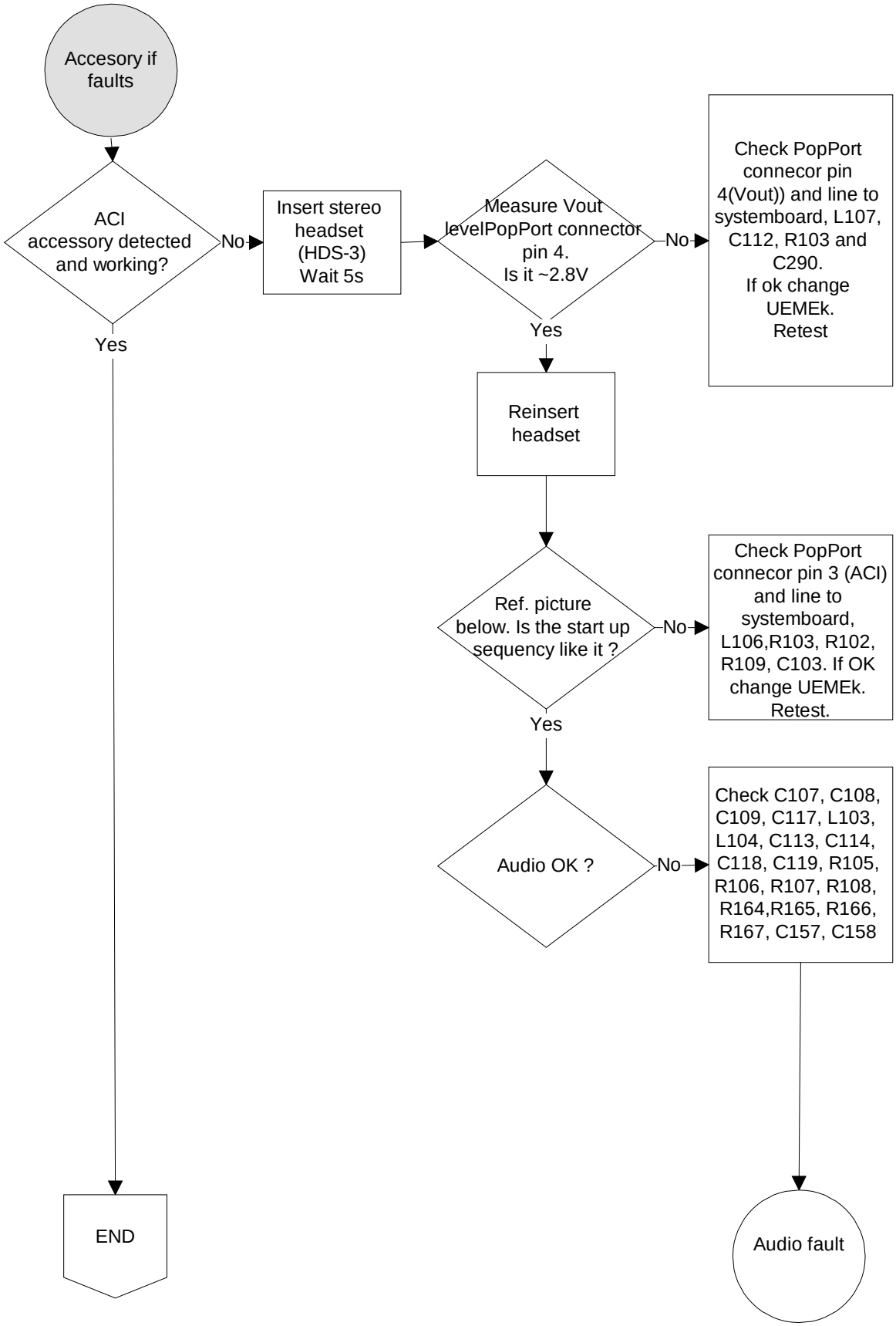
Accesory if faults
ACI accessory detected and working?
No
Yes
Insert stereo headset (HDS-3) Wait 5s
Measure Vout levelPopPort connector pin 4. Is it ~2.8V
No
Yes
Check PopPort connecor pin 4(Vout)) and line to systemboard, L107, C112, R103 and C290. If ok change UEMEk. Retest
Reinsert headset
Ref. picture below. Is the start up sequency like it ?
No
Yes
Check PopPort connecor pin 3 (ACI) and line to systemboard, L106,R103, R102, R109, C103. If OK change UEMEk. Retest.
Audio OK ?
No
Check C107, C108, C109, C117, L103, L104, C113, C114, C118, C119, R105, R106, R107, R108, R164,R165, R166, R167, C157, C158
END
Audio fault

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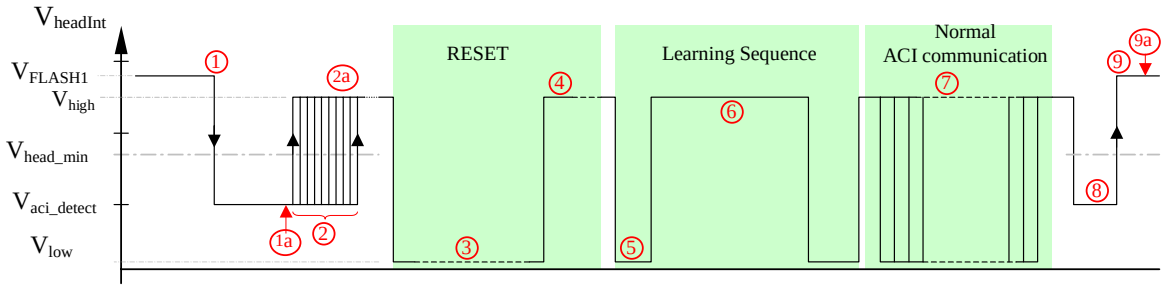
Figure 36: ACI Diagram



1. Accessory is connected (insertion & removal resistor connect to ACI line)
1a) phone gets HeadInt interrupt after 20ms check that ACI line is still low (<Vhead min)
2. Connect MBUS with HeadInt line (MBUS switch)
2a) If the phone detect a HeadInt interrupt from low to high transition in 20ms timeframe, then an advanced accessory is connected
3. ACI chip reset (3000- 4000us)
4. Power up delay (50-400us)
5. Start bit (50us)
6. Learning sequence (567-1700us)
7. ACI communication
8. MBUS is disconnected from HeadInt line (MBUS switch). After every communication.
9. Accessory is removed (no insertion & removal resistor on ACI line)
à phone gets HeadInt interrupt from ACI line low to high transition.
9a) If no HeadInt interrupt comes in the next 100ms the accessory is really removed and the phone goes in the state "no accessory".

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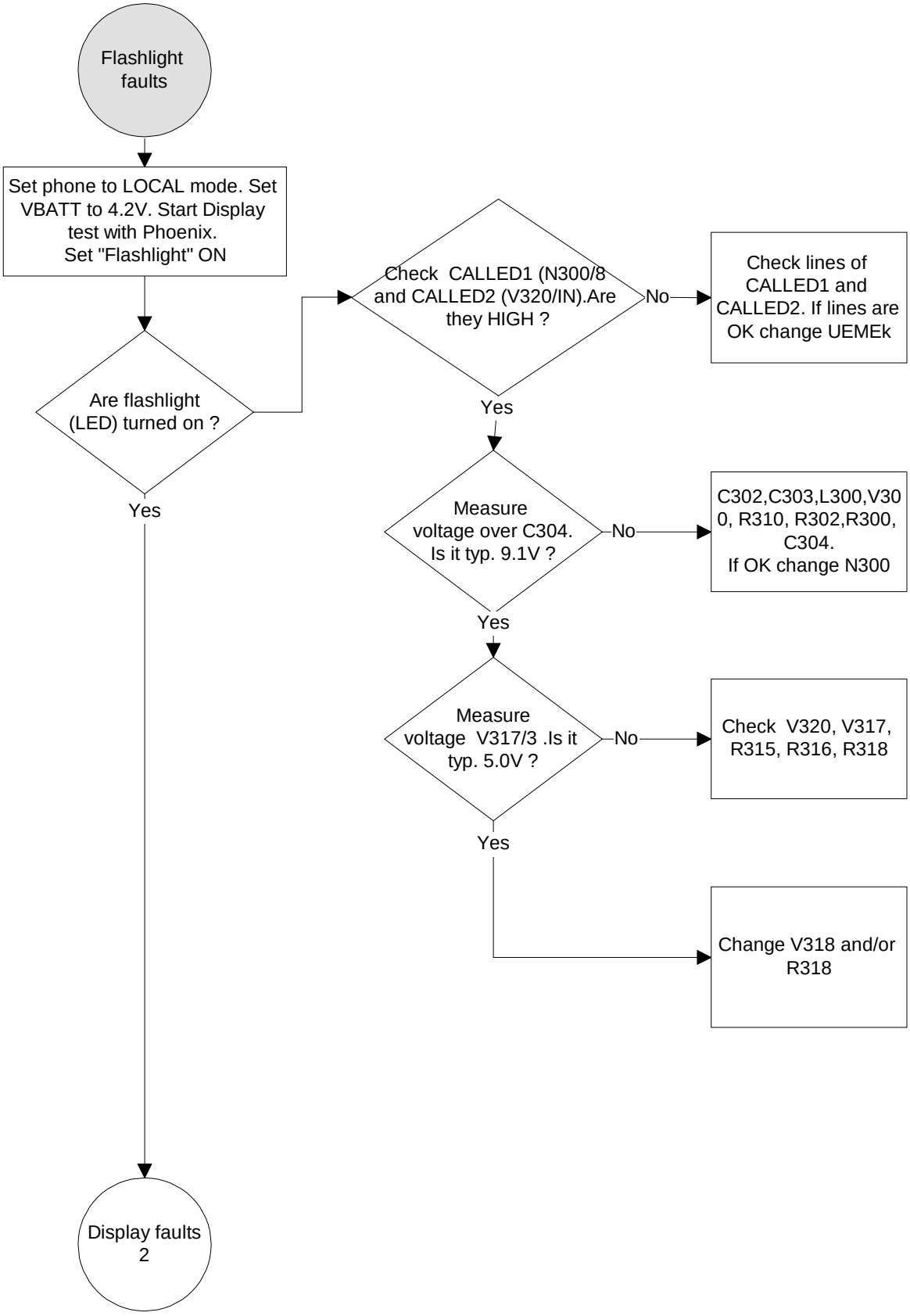
Flashlight faults


Flashlight faults
Set phone to LOCAL mode. Set VBATT to 4.2V. Start Display test with Phoenix. Set "Flashlight" ON
Are flashlight (LED) turned on ?
Yes
Check CALLED1 (N300/8 and CALLED2 (V320/IN).Are they HIGH ?
No
Check lines of CALLED1 and CALLED2. If lines are OK change UEMEk
Yes
Measure voltage over C304. Is it typ. 9.1V ?
No
C302,C303,L300,V300, R310, R302,R300, C304. If OK change N300
Yes
Measure voltage V317/3 .Is it typ. 5.0V ?
No
Check V320, V317, R315, R316, R318
Yes
Change V318 and/or R318
Display faults 2

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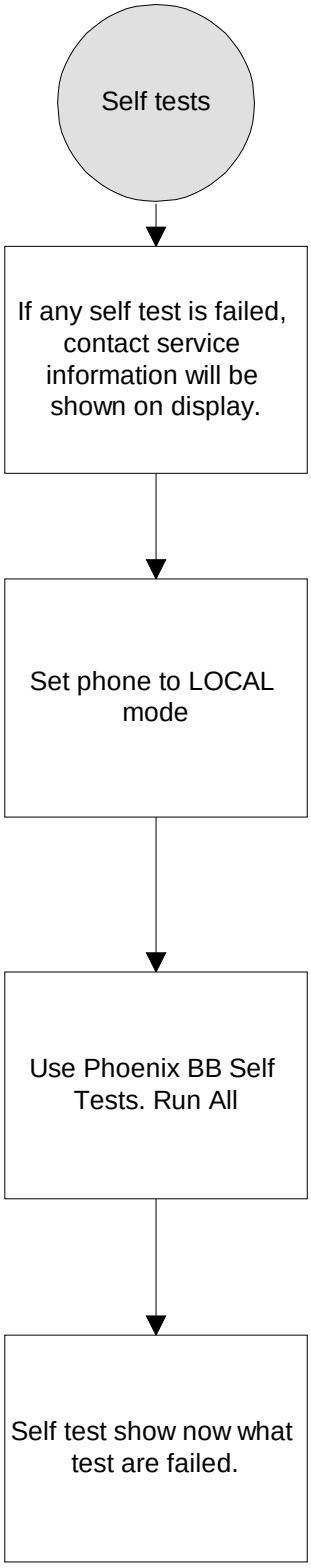
Self tests


Self tests
If any self test is failed, contact service information will be shown on display.
Set phone to LOCAL mode
Use Phoenix BB Self Tests. Run All
Self test show now what test are failed.

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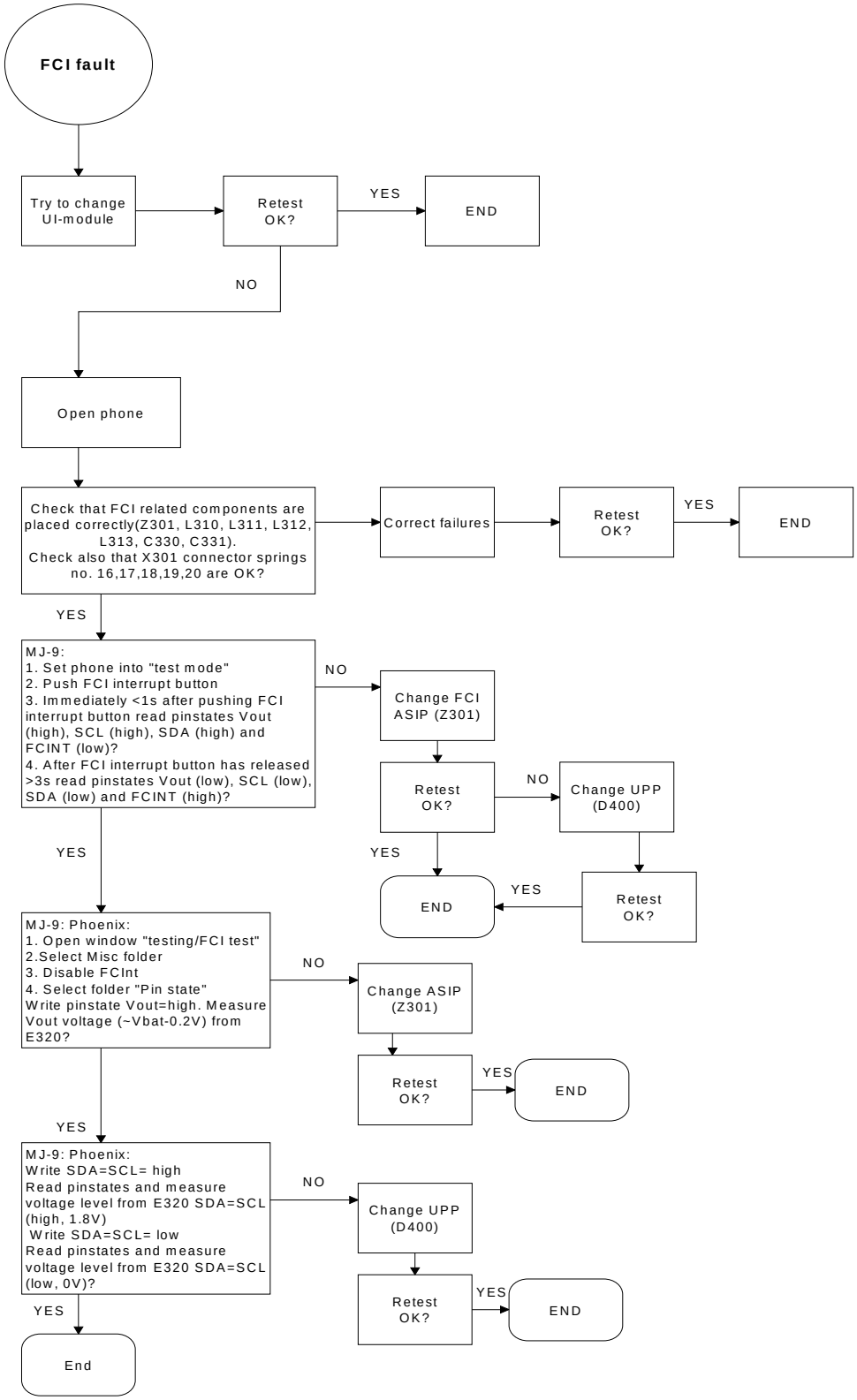
FCI troubleshooting



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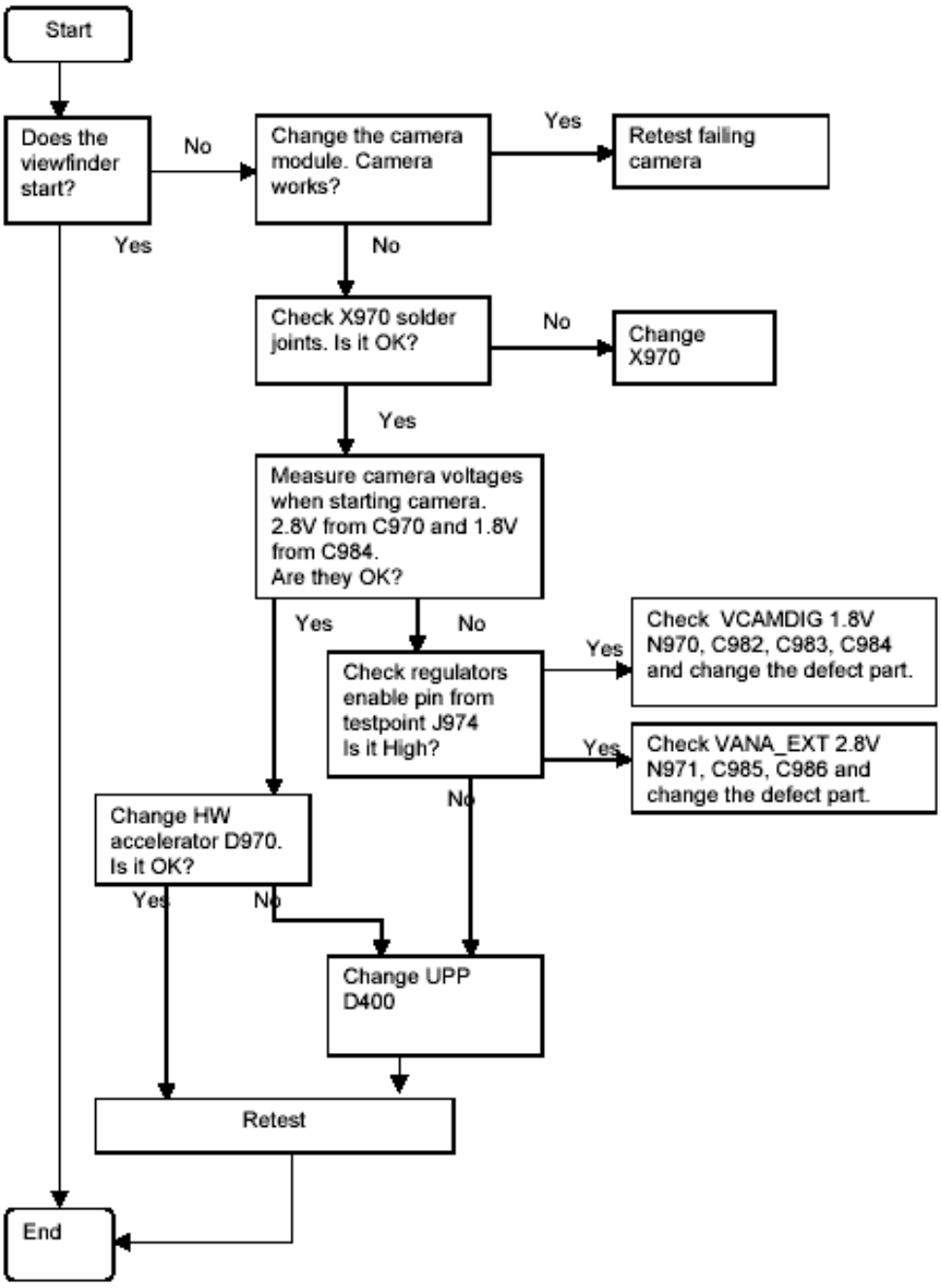
Camera troubleshooting



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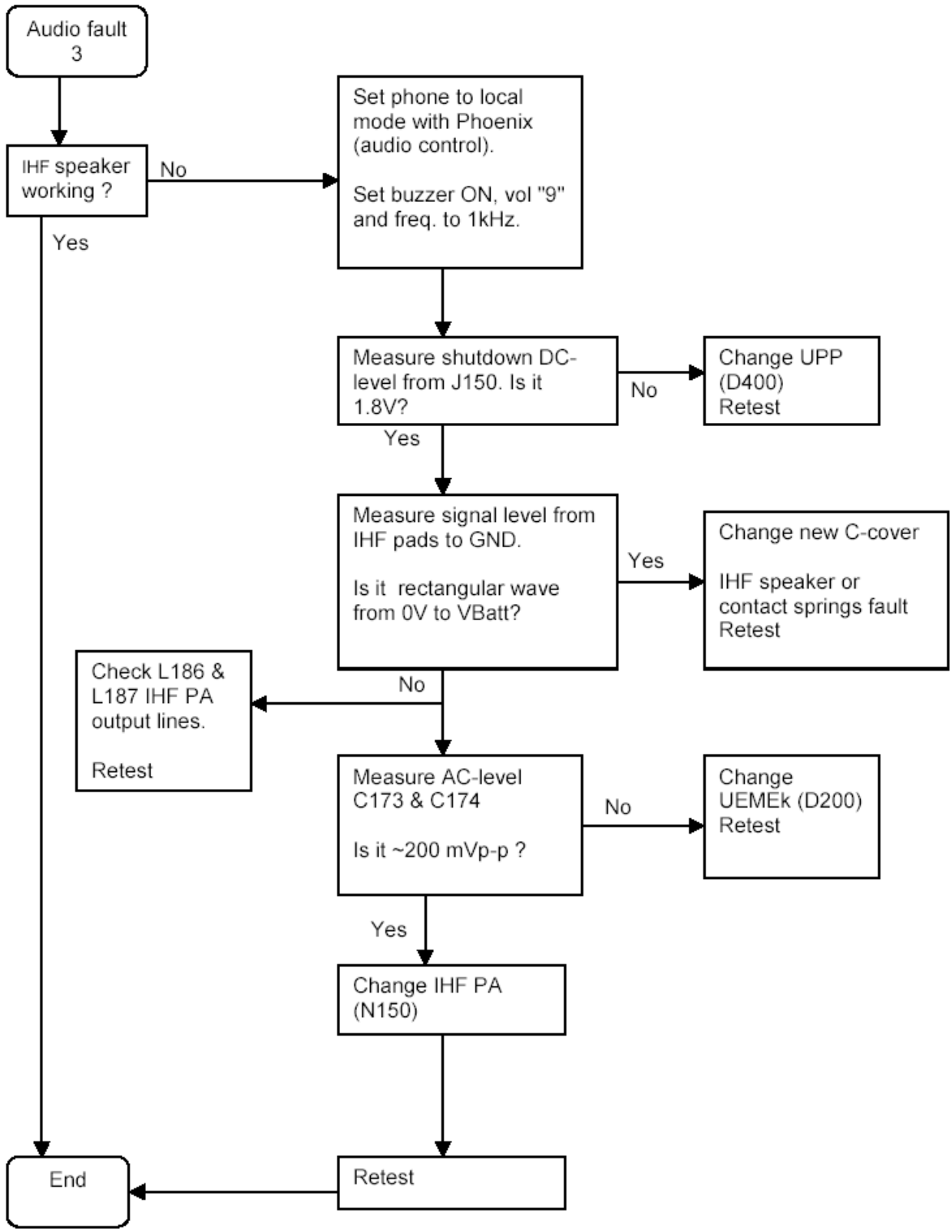
IHF troubleshooting



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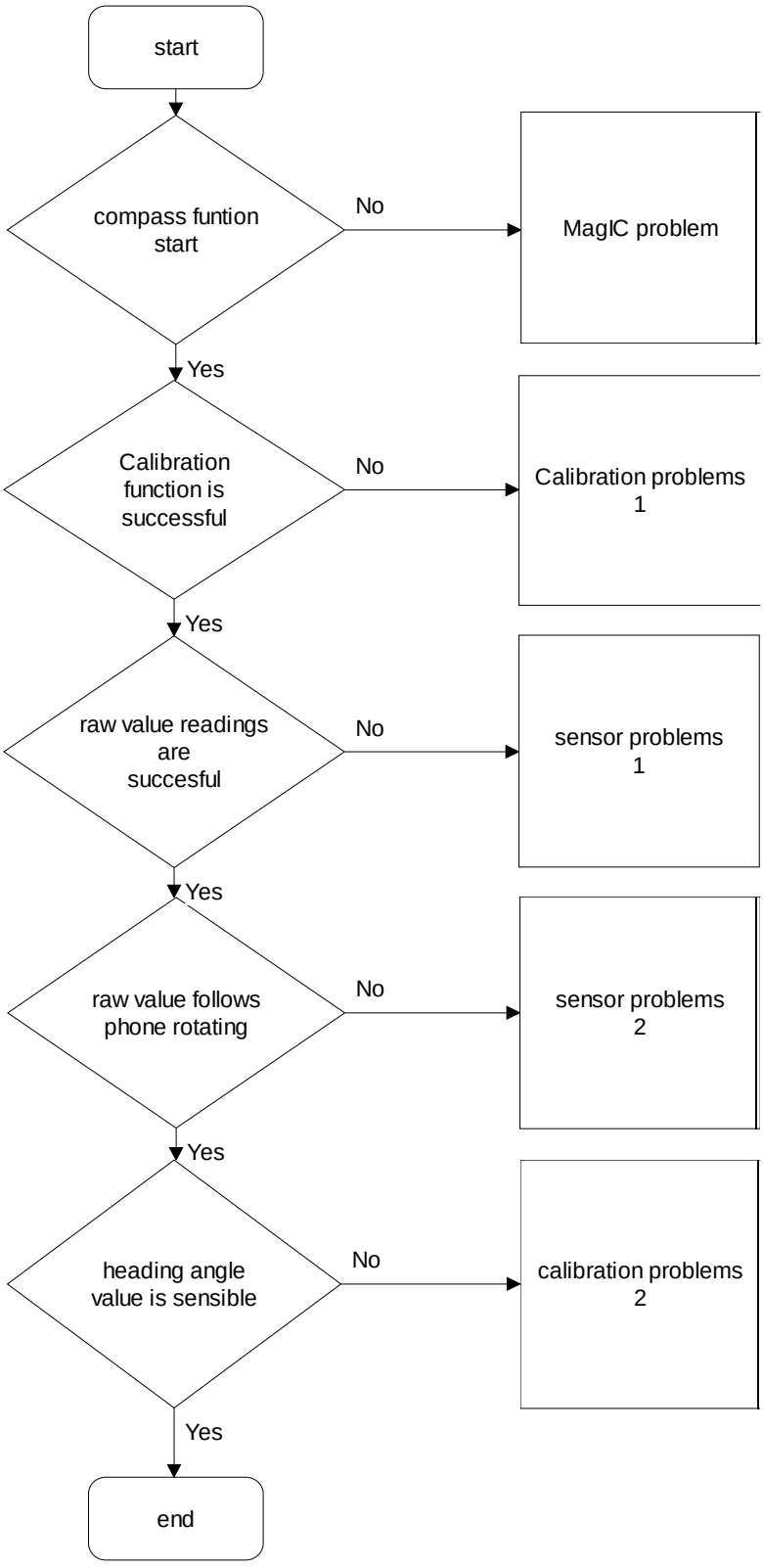
Compass Troubleshooting



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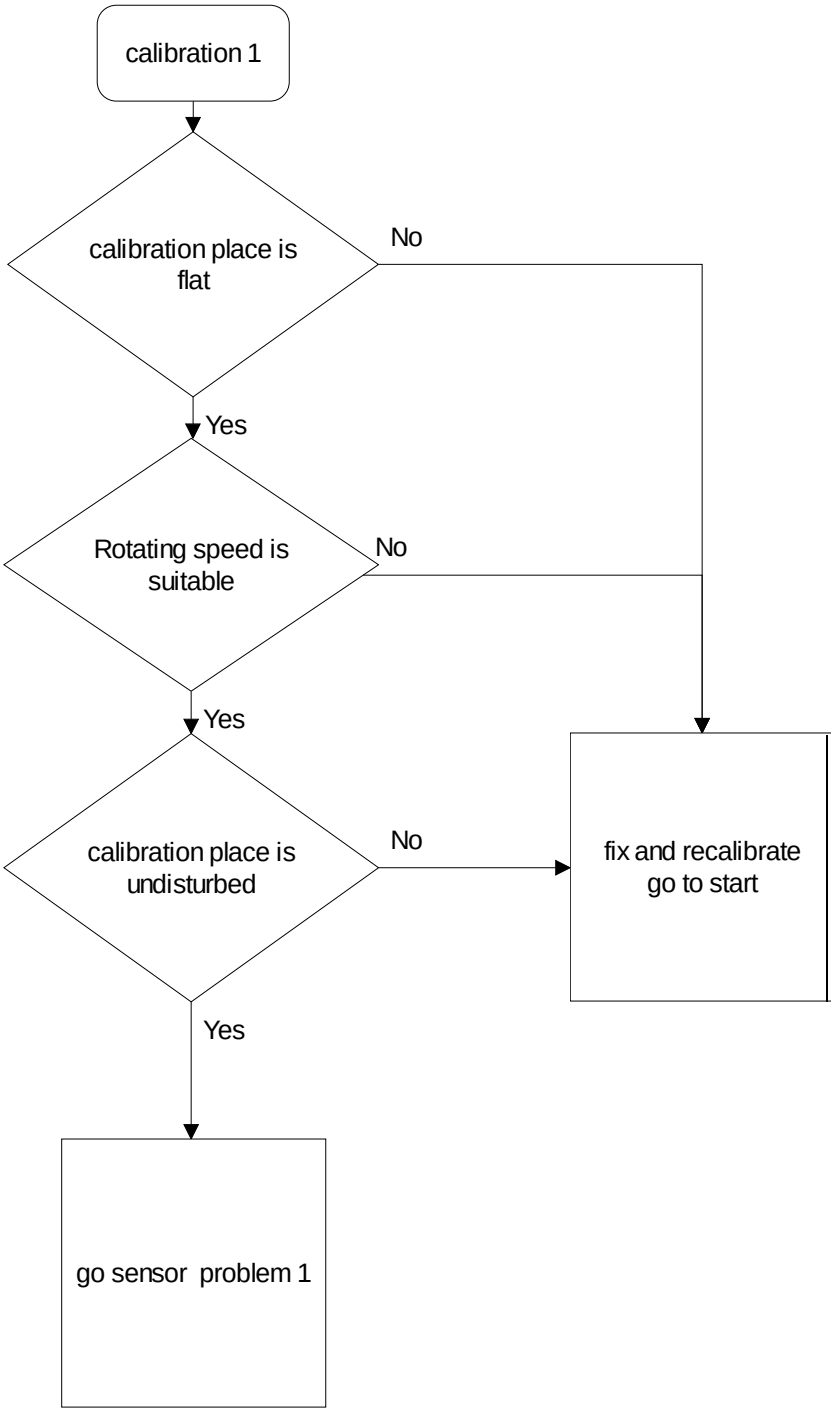
Calibration 1



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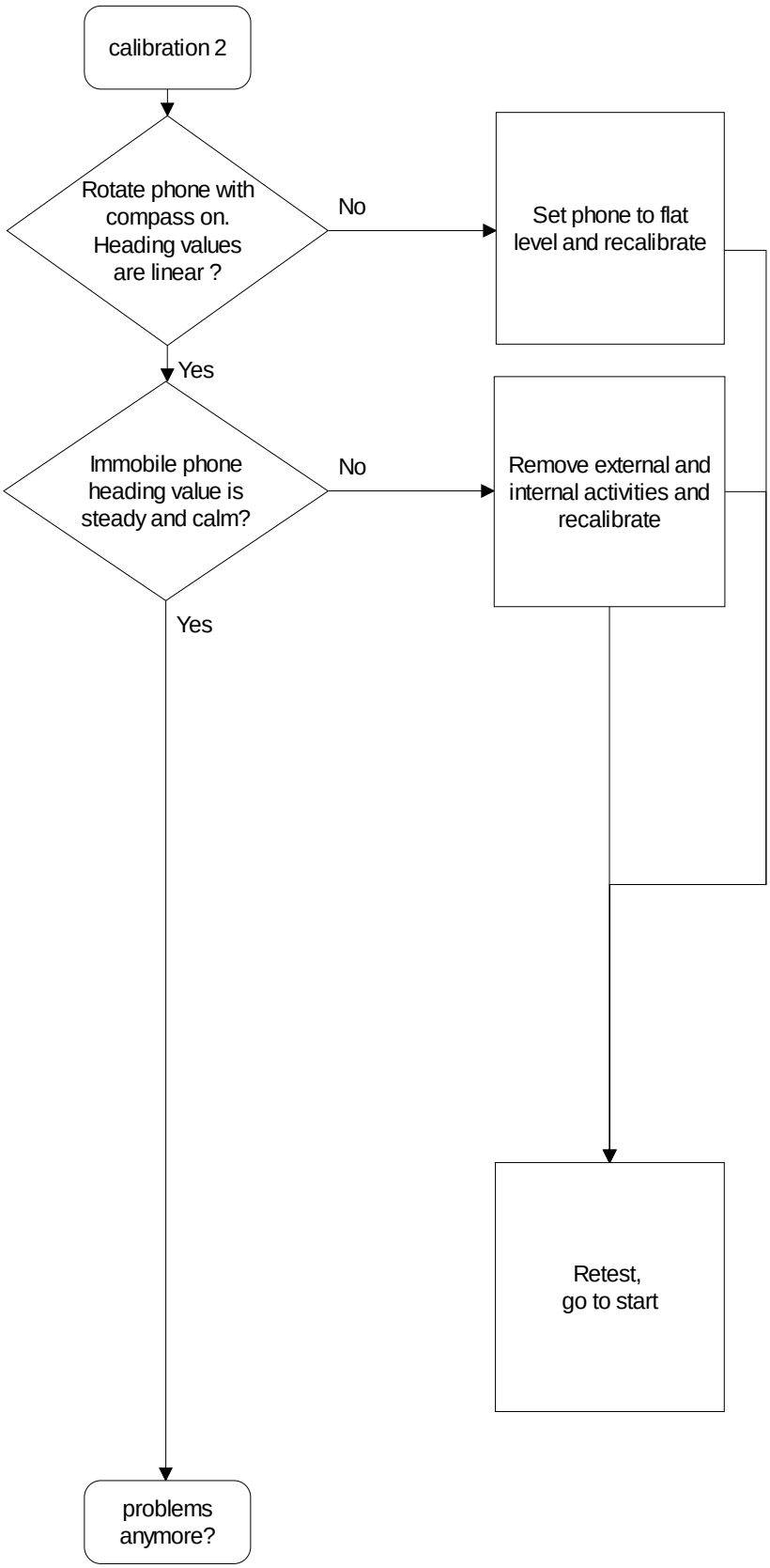
Calibration 2


calibration 2
Rotate phone with compass on. Heading values are linear ?
No
Set phone to flat level and recalibrate
Yes
Immobile phone heading value is steady and calm?
No
Remove external and internal activities and recalibrate
Yes
Retest, go to start
problems anymore?

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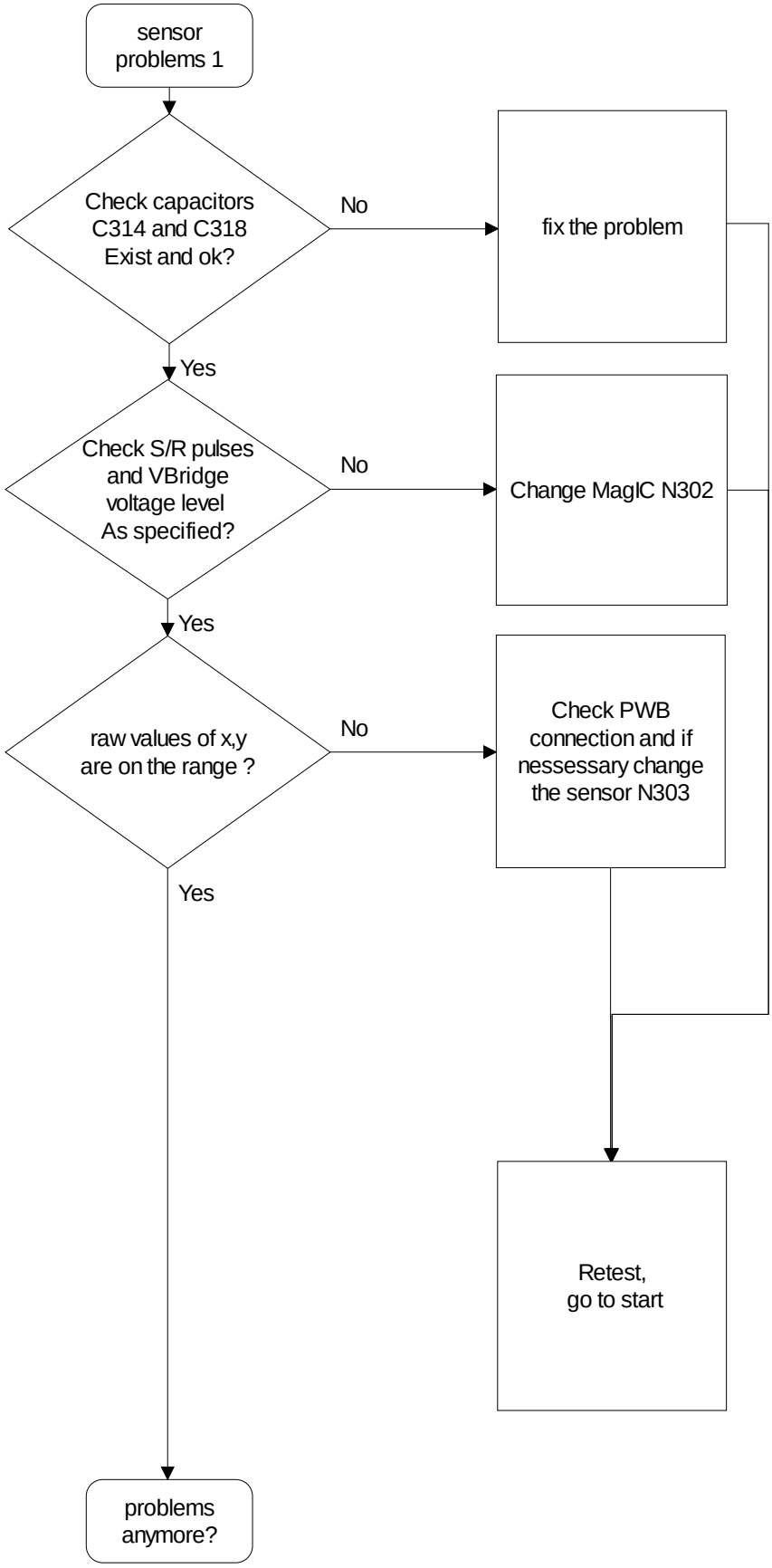
Sensor problems 1



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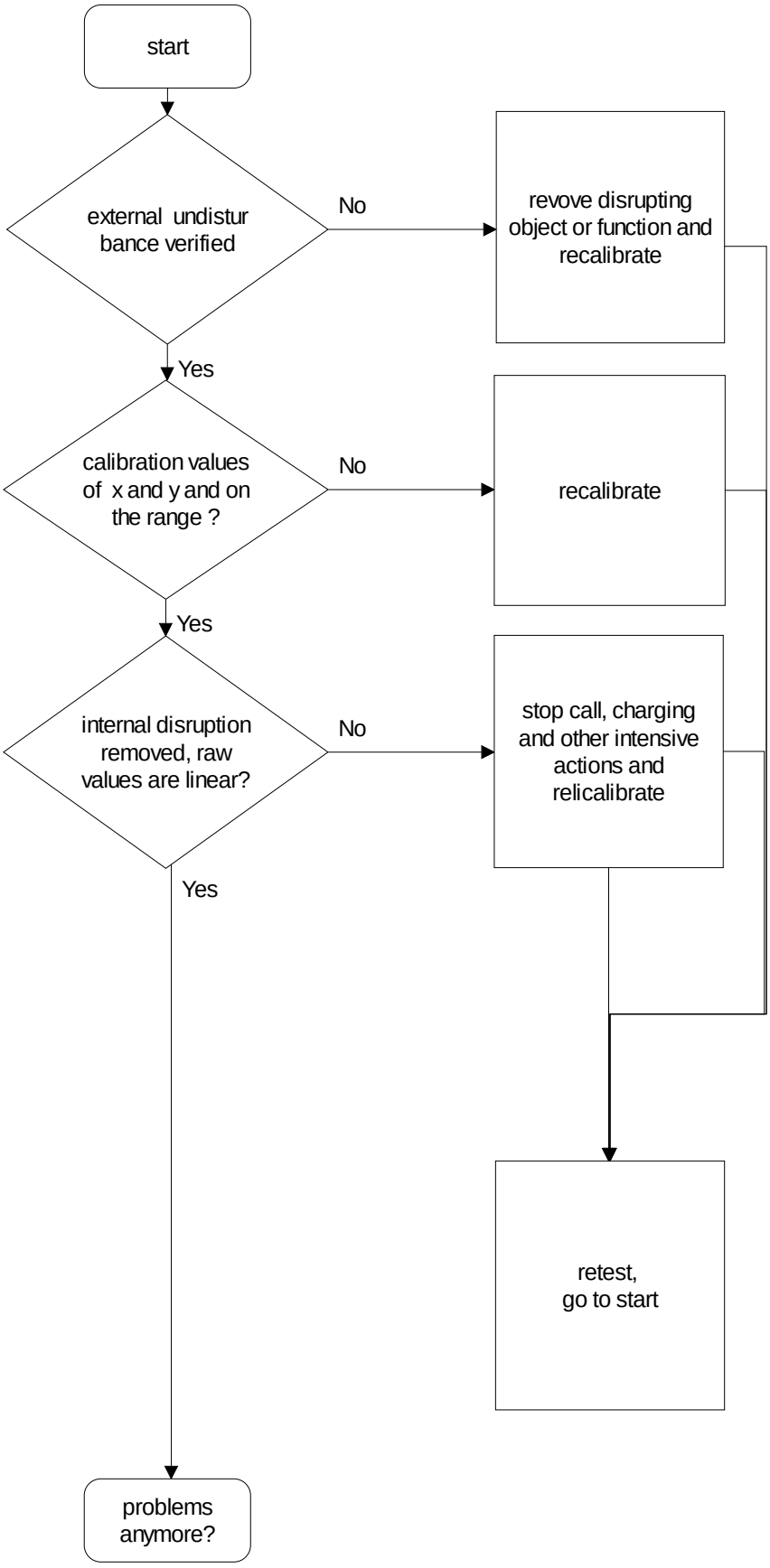
Start calibration



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Magnetometer output interface testpoints

Channel A output J331(+), J332(-), Channel B output J329(+), J328(-)

- Difference voltage is normally 0.0V between (+) and (-)

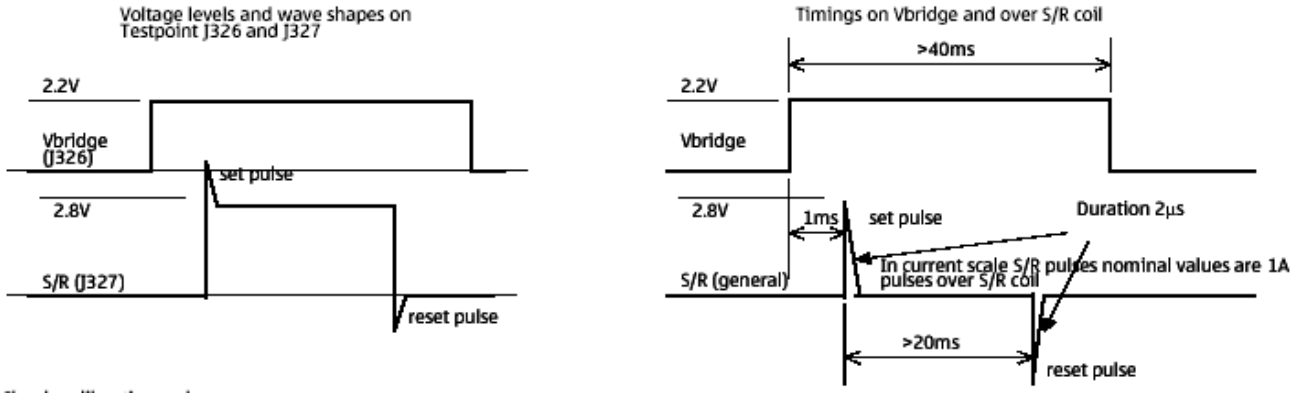
- Referred to ground output voltage is 1.1V typ. (1.0V to 1.2V)

Magnetometer control interface testpoints

Set/Reset pulse J327

Vbridge J326

Figure 37: Testpoints



Check calibration values

- x and y gain (abs(max-min)) would be range of 300 to 1700

- offsets (not precalculated) for both channels , calculated as (max- gain/2)

- normal variation would be range +-1000 to +1000

- offset values are not precalculated

- ratio of x/y gain would be range of 0.75 to 1.33

- scorra range, normal case 1.0 to 1.2

- scorrb range, normal case 0.0 to 0.2

Check compass respond with some ferrometal object

- both channels must react

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Check difference of offset strap coil

- difference of measured values must be range of 320 to 420digit for both channels

Check Set/Reset pulses and VBridge voltage

- measure with oscilloscope

- S/R pulses and Vbridge voltages are active only during the measurement phase

Check measurement bridges output voltages

- Voltages referred to ground must be near 1.1V and difference signal 0.0V

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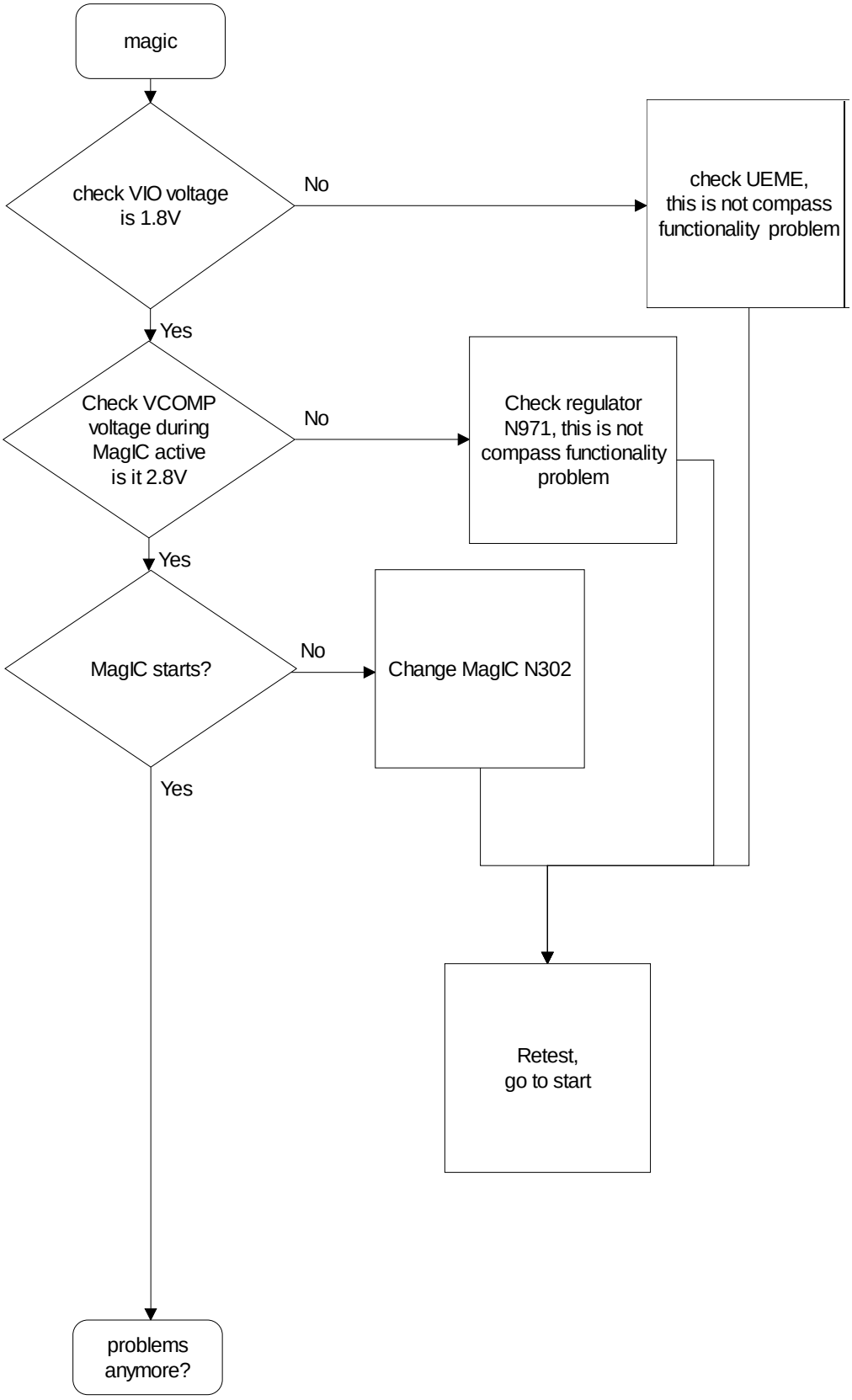
Magic troubleshooting



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FM Radio Troubleshooting

FM radio component layout

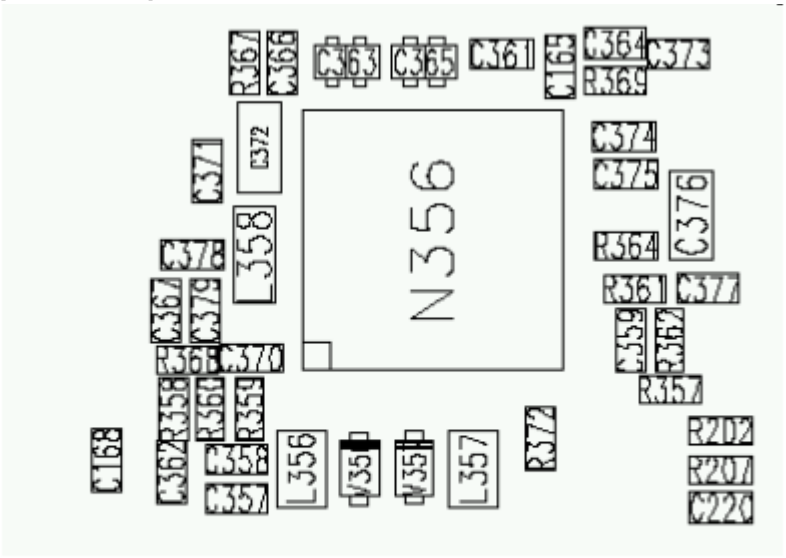

Figure 38: Component placement

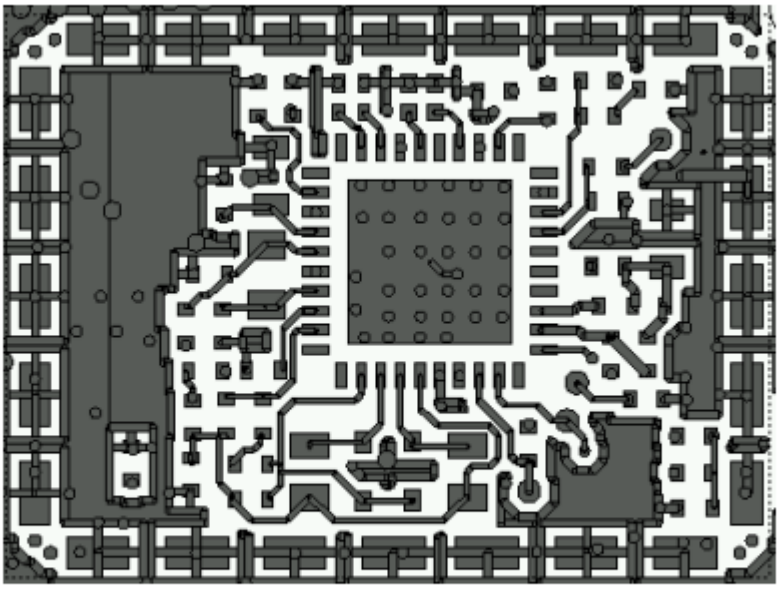

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Figure 39: Trace layout.

Figure 40: FM radio block layout.

Components L103, L104, L105, C107, C108, C109, C117, C162, C163, R164, R165, R166 and R167 are not shown in the picture. Those components are placed in baseband section, near audio amplifier N150.

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FM radio troubleshooting diagram

Notes to "FM radio troubleshooting diagram"

Use 1MHz 1X probe when measuring Audio and clock signals with oscilloscope.

Use active RF probe when measuring frequencies with spectrum analyzer.

Note 1. RF test signal parameters:

- Amplitude, A, –67.0 dBm
- Carrier frequency, f_c, 98,000 MHz
- Deviation, Δf, 75 kHz
- Modulating frequency f_m, 1,000 kHz (RF generator internal)
- FM stereo, mode R=L, pilot state ON

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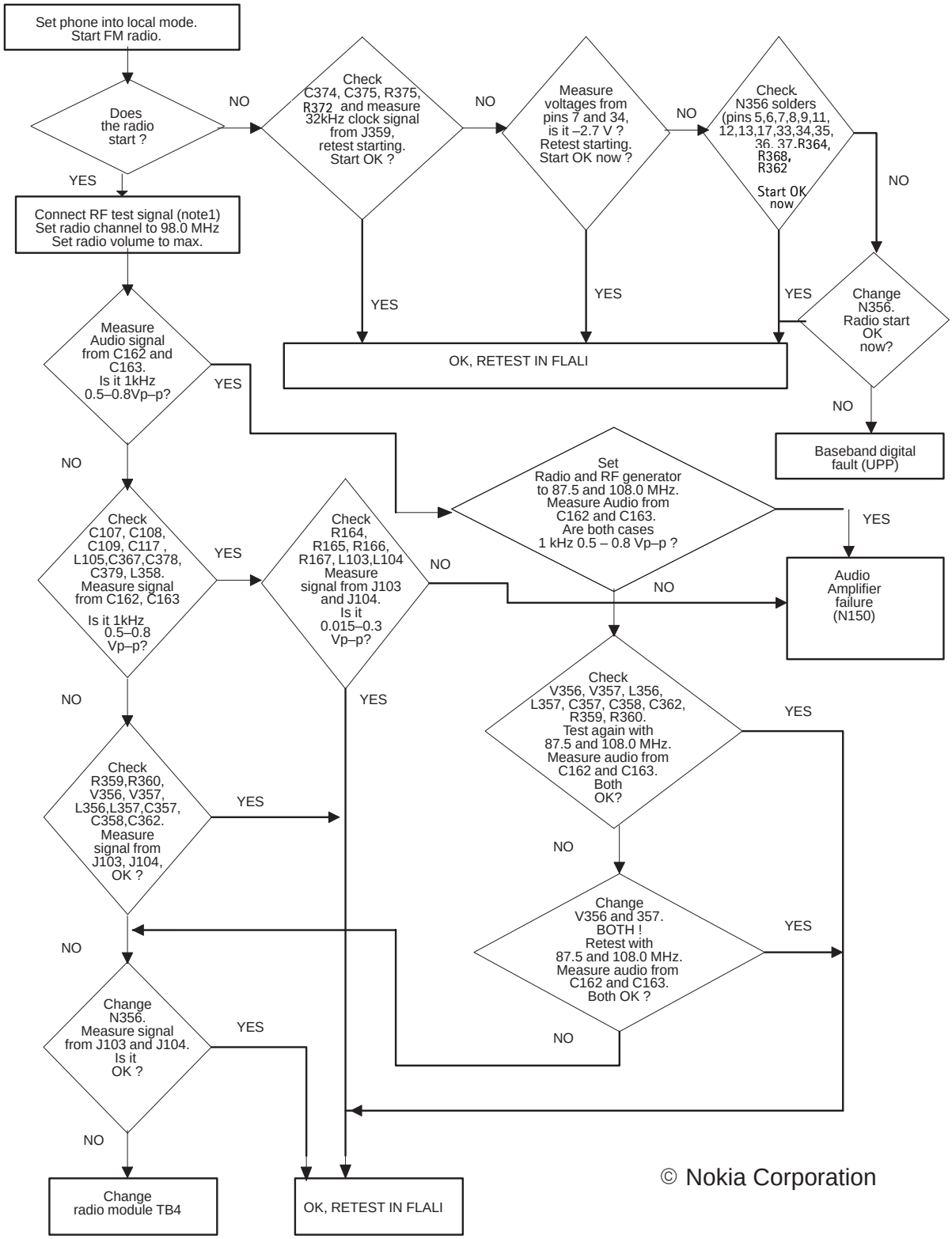
Figure 41: FM radio troubleshooting diagram


Set phone into local mode.
Start FM radio.
Does the radio start ?
NO
Check C374, C375, R375, R372 and measure 32kHz clock signal from J359, retest starting. Start OK ?
NO
Measure voltages from pins 7 and 34, is it –2.7 V ? Retest starting. Start OK now ?
NO
Check N356 solders (pins 5,6,7,8,9,11, 12,13,17,33,34,35, 36, 37.R364, R368, R362 Start OK now
NO
YES
Connect RF test signal (note1)
Set radio channel to 98.0 MHz
Set radio volume to max.
YES
YES
YES
Change N356. Radio start OK now?
OK, RETEST IN FLALI
Measure Audio signal from C162 and C163. Is it 1kHz 0.5–0.8Vp–p?
YES
NO
Baseband digital fault (UPP)
NO
Set Radio and RF generator to 87.5 and 108.0 MHz. Measure Audio from C162 and C163. Are both cases 1 kHz 0.5 – 0.8 Vp–p ?
YES
Check C107, C108, C109, C117, L105,C367,C378, C379, L358. Measure signal from C162, C163 Is it 1kHz 0.5–0.8 Vp–p?
YES
Check R164, R165, R166, R167, L103,L104 Measure signal from J103 and J104. Is it 0.015–0.3 Vp–p?
NO
NO
Audio Amplifier failure (N150)
NO
YES
Check V356, V357, L356, L357, C357, C358, C362, R359, R360. Test again with 87.5 and 108.0 MHz. Measure audio from C162 and C163. Both OK?
YES
Check R359,R360, V356, V357, L356,L357,C357, C358,C362. Measure signal from J103, J104, OK ?
YES
NO
Change V356 and 357. BOTH ! Retest with 87.5 and 108.0 MHz. Measure audio from C162 and C163. Both OK ?
YES
NO
Change N356. Measure signal from J103 and J104. Is it OK ?
YES
NO
Change radio module TB4
OK, RETEST IN FLALI
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Diagrams of FM radio signals

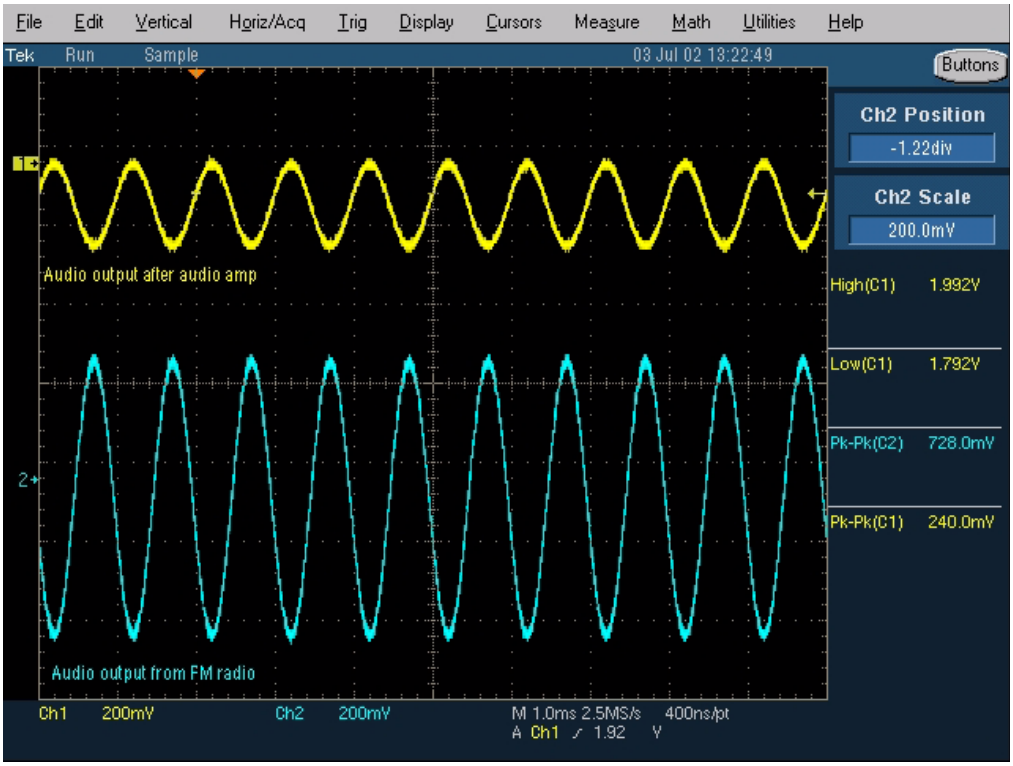

Figure 42: Oscilloscope screen shot, Audio output

Signal 1: Audio output from PWB test points J103 and J104, with FM test signal, volume 100%.

Signal 2: Audio output from FM radio pins 22 and 23(same as in C162 and C163), with FM test signal

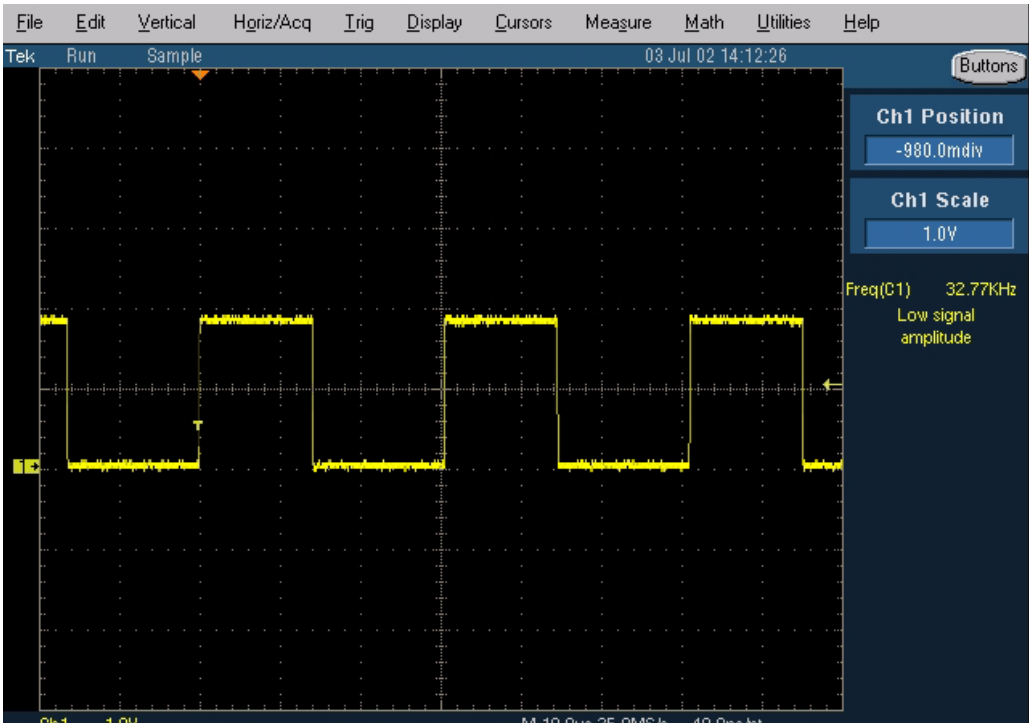

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Figure 43: FM radio clock from test point J359, 32 kHz frequency clock signal, when radio is on.

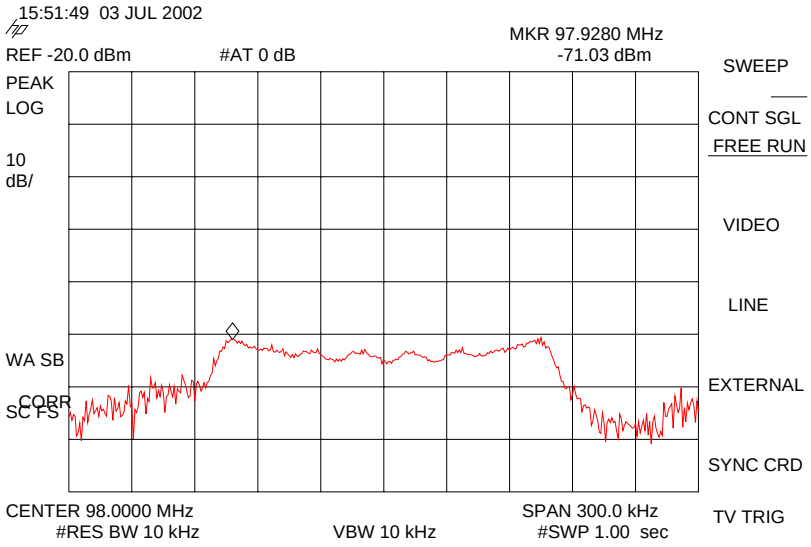

Figure 44: FM frequency from FM radio pin 37, the other end of L358, with FM test signal

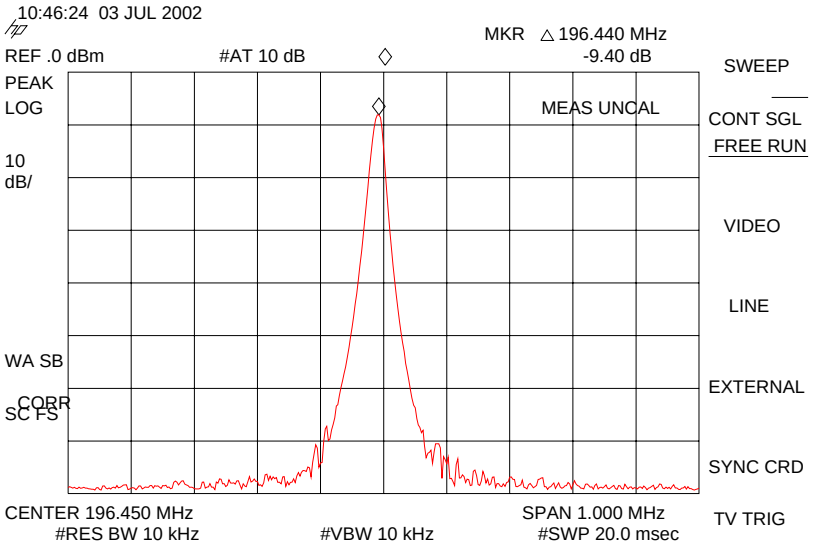

Figure 45: VCO frequency from FM radio pins 3 and 4, the other ends of V356 and V357, with FM test signal

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